DOCTOR OF PHILOSOPHY

Individual differences in visual memory, imagery style and media experience and their effect on the visual qualities of dreams

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Ewa Murzyn

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University of Dundee

INDIVIDUAL DIFFERENCES IN VISUAL MEMORY, IMAGERY STYLE AND MEDIA EXPERIENCE AND THEIR EFFECT ON THE VISUAL QUALITIES OF DREAMS.

Eva Murzyn

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for the degree of Doctor of Philosophy

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Declaration

I declare that I am the author of this thesis and that unless otherwise stated, all references cited have been consulted by me. The work of which this thesis is a record has been carried out by myself and it has not been previously accepted for a higher degree.

Singned_____

Ewa Murzyn

I confirm, as thesis supervisor, that the conditions of the relevant Ordinance and Regulations for the Ph.D. degree have been fulfilled

Singned_____

Prof. Trevor Harley

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Abstract

The aim of this research thesis was to investigate whether there are any cognitive factors that might influence reported dream colour. This question was prompted by the existence of a period of time in the early 20th century when the majority of people reported having greyscale dreams, and coloured dreaming was treated as an anomaly. On the level of individual differences, age, visual imagery abilities and memory for colour were singled out as the potential contributors to reports of greyscale dreaming. The rise and fall of black and white television and the changes in the methodology of research were preliminarily identified as the possible causes of the historical trends in the colour of dreams, and the first empirical studies in this thesis address these issues. Subsequent studies explored the role of visual imagery ability, and individual differences in cognitive representation and memory in determining the reporting of colour in dreams. Overall a total of seven studies are reported. The range of methods employed in these studies was diverse and required the development of new measures of colour memory and visual imagery. Some studies employed diaries to gather dream data and allowed cross-sectional (e.g. age) or cross-cultural comparisons. Others were more laboratory-based and explored data concerning visual memory and imagery performance with diverse dependent measures (e.g. response time data). In addition these

studies involved the development of a novel coding scheme for visual dream content. While it was impossible to decisively support or disprove the idea that greyscale dream reports reflect genuine dream experiences, the research carried out for this thesis provided many fascinating insights into the factors that determine how we dream and how we report our dreams, highlighting the role of our cognitive abilities and preferences. Moreover, the studies have uncovered novel ways in which visual imagery preferences shape how we remember and report our experiences. The implications of these findings are important not just for the methodology of dream research, but for the whole field of cognitive and applied psychology.

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CHAPTER 1: INTRODUCTION

Dreams are an integral element of our conscious lives, and have been under philosophical and then scientific scrutiny since ancient times. They have been used to bolster or overthrow philosophical theories (most notably Descartes, 1998); have inspired art (Breton, 1924) and science (Kekule's dream of benzene structure, Mendeleev's dream ad the periodic table; Barrett, 2001). When the history of dream research is reviewed, a fascinating discovery can be made: there was a period of time between 1900 and 1950's when majority of people reported having black and white dreams and when the scientific community considered black and white dreams to be normal and even desirable. While there is little information about how this trend began, it ended quite rapidly in late 1950's – coinciding with the introduction of a new dream research method (REM awakenings) and with the popularisation of coloured television. This shift in people's dream reports was matter-of-factly noted by the researchers in the 1960's and then forgotten until an article by Eric Schwitzgebel (2003) brought the issue back into the spotlight and prompted new interest in the visual qualities of dreaming. Did people really have greyscale dreams? Can people still experience them?

1.1 Three theories of dream colour

Schwitzgebel suggested that while the reports were made, people never actually experienced greyscale dreams and only misinterpreted their dream memories. Furthermore, he argued that perhaps dreams do not contain any colour qualities, as these are only added to the experience upon awakening in accordance with dreamer's expectations and the social construction of dreaming. This approach will henceforth be referred to as the 'Achromatic Dreaming' theory. While this explanation is certainly parsimonious, there are other ways of

accounting for the historical onset and cessation of greyscale dreaming. The second approach, which can be dubbed the ‘Dream Immutability’ (supported by Schredl, Fuchdzhieva, Hamig and Schindele, 2008) claims that dreams are and always have been in colour and people used to report greyscale dreams due to memory issues and external circumstances such as social pressure, exacerbated by poor study methodology. The final approach, which will be referred to as the ‘Dream Shift’ theory, states that the black and white decades did include people genuinely experiencing greyscale dreams and dream colour is flexible under the right circumstances. Each of these approaches provides a different set of predictions about what psychological, cognitive and environmental variables should be involved with the production of greyscale dream reports. The Figure 1 on page 4 presents these links.

The achromatic dreaming theory is interesting from a conceptual standpoint, since it is quite parsimonious and manages to explain all the historical changes in dream colour without leaning on any cognitive theories of visual imagery, simply relying on environmental influence and the reconstructive nature of memory. It is to some extent similar to the visual imagery approach held by Pylyshyn (1973), who proposed that what we experience as visual images is in fact only an illusion that has no basis in how the brain actually processes and stores images. However, research on visual imagery has to a large extent disproved Pylyshyn's theory and it is likely that the same fate could befall the Achromatic theory. The very claim that dreams can be generated as devoid of all colour properties is a bold assumption that has little basis in what is currently known about neurology of colour vision and imagery (Chapter 4). History of dream science has demonstrated that theoretically driven attempts to account for unusual phenomena of sleep by dismissing their existence outright have not been very successful (see Chapter 5 discussion regarding the experiential status of dreams).

The dream immutability theory postulates that, barring neurological damage, dreams can only be seen in full colour because the majority of waking reality is in colour. This approach uses a wide set of explanations for greyscale dream reports, most prominent of which are the methodological differences between the studies that can lead to biased results and the influence of black and white media and societal pressure on how people would report their inherently coloured dreams. Individual memory and attentional differences are also used to account for individual differences in dream colours.

The last position – dream shift – hinges on an explanation for why people would suddenly start to experience a fundamental change in one of their most private experiences. The main candidate for such a factor is the black and white media that was so prevalent in the early 20th century...Both the first and second approach put forward the same factors as an explanation of why people would report greyscale dreams. The only difference is that the achromatic theory applies those same mechanisms to explain the reporting of coloured dreaming, and places less power in the methodological explanations for dream colour changes.

The main issue with investigating the validity of these three approaches lies in the fact that the achromatic dreaming theory is nearly indistinguishable from the other theories in terms of the evidence it can accommodate. Moreover, the decision between the two chromatic approaches rests on the differences between what people experience and report, which often cannot be empirically accessed. If, for example, black and white media turn out to influence dream colour, it will be still very difficult to assess whether that influence affects only the reporting of dreams or the actual experience, unless the dreamers confess that those reports were consciously and purposefully modified. A similar situation arises with achromatic dreaming. Because there is currently no way to externally access the contents of

consciousness, we can never know whether a person reports a dream as coloured because they experienced it as such, or because they have memories of it being in colour. Therefore, while this thesis research was built around the idea of these three possible explanations, only very limited evidence for each of them can pre presented. Instead, the factors that could explain the dream shift became the focus of the inquiry.

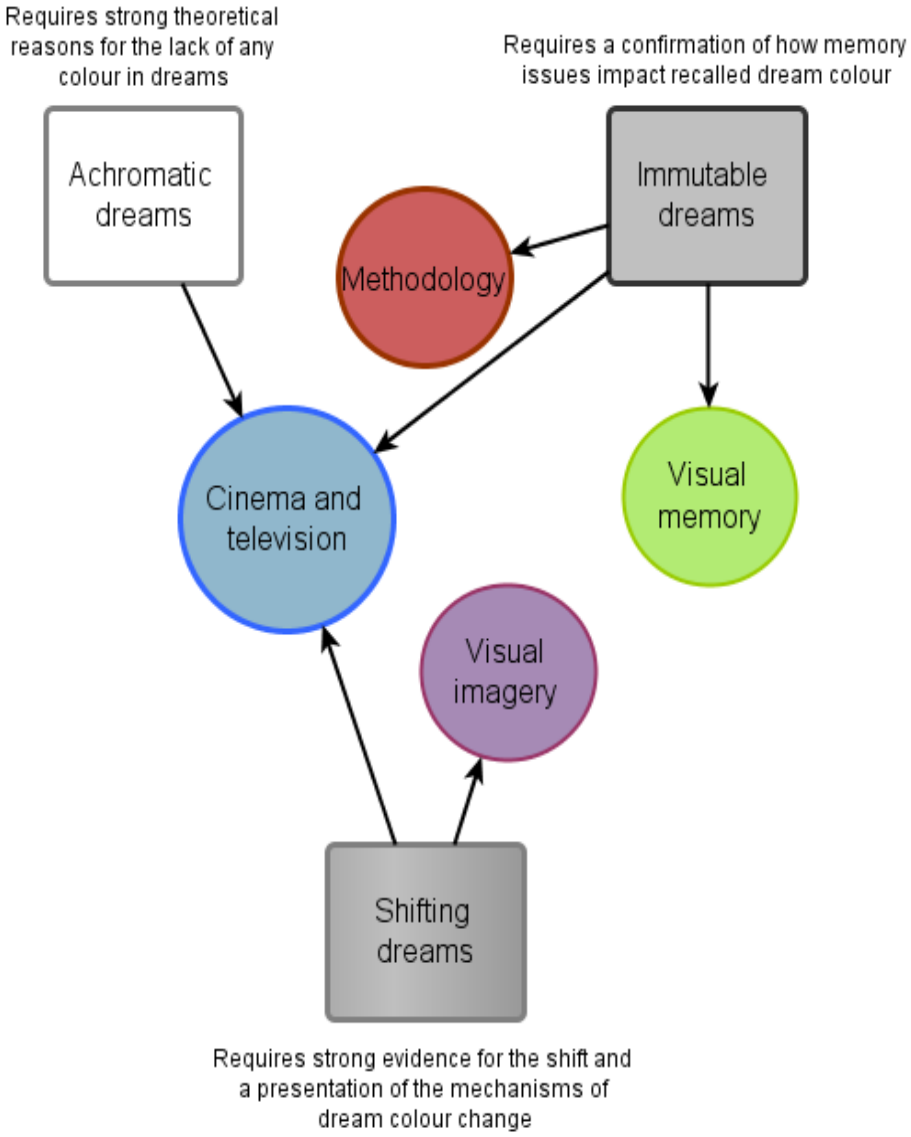


Figure 1: Three theories of dream colour

1.2 Aims of the thesis research

The aim of this thesis was to investigate the potential factors behind the historical and contemporary reports of greyscale dreaming and to perhaps find out which of the aforementioned three theories of dreaming is correct. The second chapter provides an overview of history of dream colour, starting with some of the earliest available mentions of dream colour in Aristotle's works and progressing to the latest studies carried out in the 21st century. The third chapter discusses the factors that could be implicated in the historical accounts of greyscale dreams: the influence of black and white media and the methodological differences between the studies that yielded frequent reports of greyscale dreams and those that did not. The fourth chapter introduces the factors that are probable explanations for both contemporary and historical reports of greyscale dreams, namely memory for dreams, visual memory and visual imagery style along with a brief discussion of neurological basis of colour vision and imagery. In the fifth chapter, the methodological background for dream research carried out in this thesis is presented and the most important terms for the following studies are defined. The sixth chapter presents the studies that were completed during the course of the PhD and chapter seven provides a comparison of the results obtained by those studies, along with a few novel analyses of the combined data. Finally, chapter eight presents a discussion of the findings in a wider context and provides some recommendations for future research.

CHAPTER 2: HISTORY OF DREAMING

This chapter will trace the written history of colour in dreams, starting from the earliest available sources, and ending with most recent discoveries along with a discussion of modern research on dream colour in primitive cultures. The aim of this chapter is to present the available evidence for the presence (or absence) of colour in dreams and to showcase the historical theories of dreaming insofar as they are relevant to the question of colour in dreams.

2.1 Ancient and medieval sources

Some of the earliest written sources about dreams come from ancient Greece and they present a bewildering array of different approaches. The Greeks believed that dreams are divine occurrences during which the soul either travels through the world and interacts with it, or is transferred to a semi-mythical world of dreaming to communicate with the gods (Barbera, 2008). Most importantly, Greeks always talk about 'seeing' a dream, as opposed to just having one (Barbera, 2008). Epicureans believed that dreams were produced by images that emanated from actual physical objects and found their way into the sleeping person's eyes, producing a bizarre conglomerate of images in the dreamer's mind (Stewart, 2004). In Plato's dialogues Socrates pointed out that it is impossible to distinguish between dreams and waking life on the basis of sense experience only (Dreisbach, 2000), as in dreaming the soul simply wandered through the waking world. The first scientific approach, which was advocated by Heraclites, Aristotle, Cicero and Pliny the Elder, stated that a dream was a private occurrence which 'is nothing but the retreating of the soul into its own midst' [Pliny the elder, as quoted in Miller, 1998] to spin irrational stories unconstrained by external reality.

According to Aristotle's treatise 'On Dreams' (1996) dreams contain both faculties of senses and reason: '*For [in dreams] we not only assert, e.g. that some object approaching is a man or a horse which would be an exercise of opinion, but that the object is white or beautiful, points on which opinion without sense-perception asserts nothing either truly or falsely'*, and are a reflection (though sometimes distorted) of the stimuli that enter the senses during the daytime. More specifically, he does mention colour as one of the sensory impressions likely to appear during sleep (Gallop, 1996). It is possible to conclude that Greeks believed that dreams possess life-like visual sensory characteristics, including colour (although the example of a white horse is somewhat inconvenient for this argument). A later source - the collected dreams of Vibia Perpetua, an early Christian martyr who lived in the 1st century AD (Miller, 1998) - also contains dream reports which explicitly mention colour: 'He was wearing the purple, loosely, with two stripes crossing his chest, and patterned sandals made of gold and silver, carrying a baton like a fencing-master and a green bough laden with golden apples' (Miller, 1998, p.162). Once again, it is important to acknowledge that all of these colour terms mentioned have a symbolic meaning attached to them in the Judaeo-Christian culture, and thus it is possible that they were used not to faithfully describe the visual content of the dream, but to convey a deeper message through the dram narrative. In early Christian art, the colours used to paint murals and icons were not dictated by realism, but by the divine symbolism and the concept of what should be (Gombrich, 1995). However, a fully colourless dream would also hold potential for deep symbolism by the virtue of contrast from reality, and thus is symbolic meaning was the driving force behind dream reports, such elements would probably be mentioned.

2.2 Early modern times

Throughout the early modern times, dreams were not considered as objects of separate inquiry, but as phenomena that can be used to bolster or disprove epistemological theories. Descartes (1998) used the observation that dreams are indistinguishable from reality on the basis of sensory information as a major stepping stone for his philosophical system. He stated that 'everything the soul perceives by means of the nerves [i.e. sensations] may also be represented to it through the fortuitous course of the spirits [i.e. in dreaming]'; and on other occasion remarked that as he is observing the changes of colour in a piece of wax he can think of no reason why such perceptions could not come to him in sleep (Descartes, 1984). On this premise of dreams being indistinguishable form reality Descartes built his philosophical argument that culminated in the proof for the existence of a benevolent god. The overall approach to dreams present in philosophical thought of the time was that they were perceptually indistinguishable from waking life experience, and differed from it only in lesser constancy (Pascal, c.1660/1995), more absurdity (Hobbes, 1651/1968), less vividness (Berkeley, 1710/1975) and a lack of goal-oriented behaviour (Leibniz, 1670/1969). Hume specifically referred to dreams as faded impressions (Hume, 2008); however it is hard to distinguish whether this judgement is more directed at the dreams themselves, or their memories recovered during waking; or whether Hume was referring to the visual modality in particular or was simply commenting on the paucity of other sensory elements in dreams.

The more common sources, such as dream interpretation manuals often cited colour as an important part of a dream that should be interpreted according to the symbolic meaning of a given colour, and the dream narratives from this time sometimes mention various colours: 'looking out I saw I the south three great red streams(…)' (Sobel, 2000, p. 68). In general, it can be said that the sources from the 17th and 18th century do not contain any mentions of

greyscale dreaming, and all of the dreamers and philosophers consider dreams as phantoms indistinguishable from reality.

2.3 19th Century

During the 19th century psychology started its journey as an independent scientific discipline, divorced from philosophy, and dream research began to receive a more systematic treatment. When the incidence of sensory experiences (and visual impressions in particular) in dreams was investigated, Calkins (1893) found them to be present in 57% of the 400 dreams of 2 subjects, Monroe (as quoted in Ratcliff, 1923) found that sight impressions were present in 67% of dreams taken from 55 women students, while Weed, Hallam and Phinney (1896) found visual impressions in 84% of dreams of 7 subjects. These numbers seem very low, but there is little information on how the visual features were extracted from the dream reports. One of the more pertinent theories regarding the origin of dreams, first presented by Henri Bergson and later developed by Ladd (1892), stated that the visual aspect of dreams is formed from the small coloured spots (flashes of colour) that are seen upon closing of one's eyes and are the effect of retinal activation. The spots, when falling asleep, would coalesce into visual scenes consistent with the emotional and cognitive content of the dream. Thus, a green field with white spots can lead to a dream of a grassy field with daisies, or a billiard table with balls (Ratcliff, 1923), depending on the inclinations of the dreamer. An interesting side of this approach (and one so obvious that no psychologist commented on it) is that it assumed that dreams were naturally in colour.

The dream reports from the 19th century also routinely contained mentions of colour: 'I beheld the most beautiful clumps of iris covered with a perfect wonder of golden blossoms! Little dragon-flies with blue silk wings came (…)' (Ratcliff, 1933). Freud's own dream

reports as well as the reports of his patients included colour terms (Freud, 1991) and he mentioned that when he could clearly remember colours, for example '(…) the deep blue colour of the water, the brown of the smoke coming from the ship's funnels and the dark brown and red of the buildings (…) (Freud, 1991, p.697) he could always trace the salient colours to some striking visual memories from waking life. On a different occasion, though, he remarked that colours can serve as a code for the dream's hidden meaning; for example a dream of girl dressed in white might be interpreted as a memory of a Miss White (Freud, 1991, p.538), depending on other circumstances. When Jung developed his theory of dreaming, he placed a strong emphasis on colours and saw them as symbolically linked to the archetypes that are expressed in dreams. The colours present (or absent) in a dream could be used to diagnose personal issues and guide the person to complete self-actualisation (Jung, 2002). Overall, while the 19th century academics and dreamers were sometimes in disagreement regarding the source and role of colour in dreaming, they were sure that dreams are experienced in colour.

2.4 Early 20th century

The early 20th century brought with it more systematic quantitative studies of dreaming along with the development of the psychoanalytical approach – it is also when the first mentions of frequent colourless dreaming can be seen. The wave started with Bentley (1915), who wrote that only 20% of dreams contain colour. 18 years later Middleton (1933) noted that the majority of college students report not having any colour imagery in their dreams. His second questionnaire study in 1942 (Middleton, 1942) concluded that only 10% of college students reported colour in dreams frequently or very frequently – a proportion similar to

students who reported coloured hearing. Another 50% reported experiencing colour imagery rarely or occasionally, and the remaining 40% did not see any colour in their dreams. Subsequent studies only confirmed this trend: in 'The Meaning of Dreams' Hall (1953) commented that only one dream in three has some colour in it, and that there are more people who never experience colour in dreams than people who do experience it. DeMartino (1953) found that only 17% of his undergraduates claimed to see colour in their dreams at least once a month. And in 1958 Tapia, Werboff and Winokur found that only 9% of people reporting to the hospital at Washington University in St. Louis for non-psychiatric medical problems reported having coloured dreams, compared with 12% of neurotic men and 21% of neurotic women. Coloured dreams were referred to as 'Technicolor' and were understood to be rare and somewhat unnatural occurrences – 'Ordinary dreams are like the old silent films, without sound or Technicolor' (Garma, 1961).

Few explanations were offered for this state of things in the strictly research literature – Hall (1953) mentions that he did not find any personality differences between people who experience 'chromatic' and 'achromatic' dreams, and that he was not able to discover any fixed colour meanings that could aid dream interpretation. The majority of justifications for colourless dreaming appeared on the grounds of psychoanalysis, as a development of Freud and Jung's ideas. One account (Calef, 1954) stated that colour in dreams can be understood as either an actual reproduction of previous sensory impressions, a symbol for other sensory impressions or a sign of regression. According to this theory, all children dream in colour until the onset of repression (around the latency phase) which erases colour from the manifest dream of most adults – unless the person is suffering from exhibitionistic and scoptophilic impulses, in which case colour is the last line of defence as it keeps these impulses from entering the dream in a more disruptive fashion. Other explanations of coloured dreaming

mentioned that coloured dreams were connected with early childhood memories (Calef, 1954); or that colour is the expression of repressed anal excremental contents (Garma, 1961), since in psychoanalytic theory painting is a sublimation of the primal urge to smear with excrements. Overall, psychoanalytic literature was in agreement that colour was an unusual occurrence (Knapp, 1956) that could be diagnostic of underlying psychological problems – a conclusion that was supported by the previously mentioned fact that neurotic hospital patients did report more coloured dreams than non-psychiatric controls (Tapia et al, 1958). It is quite interesting how the psychoanalytic practitioners found ways to explain the colourless dreams of their patients without referring back to Freud's and Jung's original ideas on dream colour. While there is no explicit discussion of this shift in the literature, it is reasonable to say that such a departure from the works of the founders could not have been made without a valid reason – in this case, most probably the overwhelmingly colourless dream accounts relayed by the psychoanalytic patients.

Interestingly, there was one artistic movement active in the early 20th century that was inspired by the bizarreness and vividness of dream imagery and which produces numerous works depicting vivid colour aspects of dreaming: Surrealism. Salvador Dali even created a technique for maximising dream recall by falling asleep while holding a metal object in his hand – when he would start dozing off, the item would slip from his hand, land on the floor and awaken him, allowing for clearer recall of the sleep onset dreams and hallucinations (Dali, 1993). All of the works he thus created were in brilliant colour, which stands in contrast with the prevailing attitude about dream colour in the early 20th century.

2.5 Late 20th century

Only 4 years after the last study that concluded colour in dreams to be a sign of pathology was published, Kahn, Dement, Fisher and Barmack (1962) reported that with careful questioning close to the time of dreaming colour was found in 83% of dreams. Berger (1963) found that 71% of dreams he examined scored positive for the presence of colour, with 40% certainly containing colour, while Snyder, Karacan, Tharp and Scott (1968) having analysed 635 REM dream reports concluded that perhaps all dreams contain colour. In the same year Herman, Roffwarg, and Tauber (1968) found that coloured dreaming was reported after 69% of REM awakenings of their subjects, and that the number of coloured objects in dream reports increased as the night progressed. In a longitudinal study of 6 subjects in a sleep laboratory Padgham (1975) found that roughly half of their dreams contained colour and, interestingly, that not all colours were equally represented – dream memories were lacking in saturated blues and purples. Finally, Jankowski, Dee and Cartwright (1977) stated that in their sample of REM dreams gathered from 18 participants colour was present in 62% of awakenings, the incidence of colour increased with each REM sleep period, and 89% of the participants recalled at least a single dream with colour in it. Most recent studies have found that the majority of college students dream in colour (Schwitzgebel, 2002; Schwitzgebel, 2003) – 62% dream only in colour, a further 27% said they experience coloured dreams at least occasionally, and not a single person reported having only black and white dreams. The most recent study (Schredl, Fuchedzhieva, Hämig and Schindele, 2008) found that university students rate about 10% of their dreams as black and white. However, when participants were questioned about the presence of colour immediately after the morning recall, the incidence of 'black and white' dreams fell to 2.7%.

There are two recent studies that do not fit into the trend of universal coloured dreaming. A broad survey of Austrian population of various ages (Stepansky, Holzinger, Schmeiser-Rieder, Saletu, Zeitlhofer and Kunze, 1998) reported that only 37% of their sample had coloured dreams, and that there were significant age differences in the incidence of coloured dreams, with 48% people under 30 years reporting coloured dreams as compared to 35% of 30-50 year olds and just 31% of people over 55 years. Then, a study carried out in China (Schwitzgebel, Huang and Zhou, 2006) found that the rates at which people report colour in dreams differ between cultures – a mean of 40% of Chinese respondents said that they experienced colour in dreams at least occasionally (as compared to 80% of US respondents; Schwitzgebel, 2003). Even more importantly, they also found marked regional differences – 52% of Chinese respondents from technologically advanced regions reported colour in dreams at least occasionally, while only 39% people from intermediately advanced and 28% people from least advanced areas claimed to see colour in dreams.

2.6 Overview

As this historical review demonstrates, that the idea of colourless dreaming was never entertained until the early 20th century. While the available evidence from the earlier times does not allow us to draw conclusions as to the actual incidence of colour dreaming, it does provide support for the claim that coloured dreaming was seen as a normal occurrence – both by philosophers (the theoreticians of dreaming) and the dreamers themselves. It is only in the early 20th century that coloured dreams were singled out as something unusual. It would indeed be odd for the numerous naturalists, philosophers and poets would not comment on the unusual visual qualities of dreaming if greyscale dreaming had been present in those times. If the presence of colour in dreams was rare occurrence before 20th century, it would have

certainly been used as an argument in the philosophical debates about cognition and consciousness. The appearance of greyscale dream reports in the 20th century was a somewhat sudden occurrence, and it followed a particular pattern. The early studies of dreaming reported that colour was at least occasionally present in dreams for the majority of the population (Middleton, 1942), while the last few studies in the 1950's reported colour as an unusual (present in 9% of the population) and possibly pathological occurrence (Tapia et al, 1958). Even more remarkably, the 1st study from the 1960's (Kahn, et al. 1962) presents a massive increase in the reported incidence of colour in dreams, with colour found in 83% of dreams – and the later studies uphold this estimate. The only exceptions to this trend were the results reported by Stepansky et al (1998) and Schwitzgebel, Huang and Zhou (2006). Overall, as seen in Figure 2 on page 16, people (as far as we can tell from the historical sources) have dreamt in colour until the early 20th century, when the reported frequency of colour dreams started to drop, reaching the minimum in late 1950's, after which it rebound sharply and steadily rose until it reached almost 100% in the modern times.

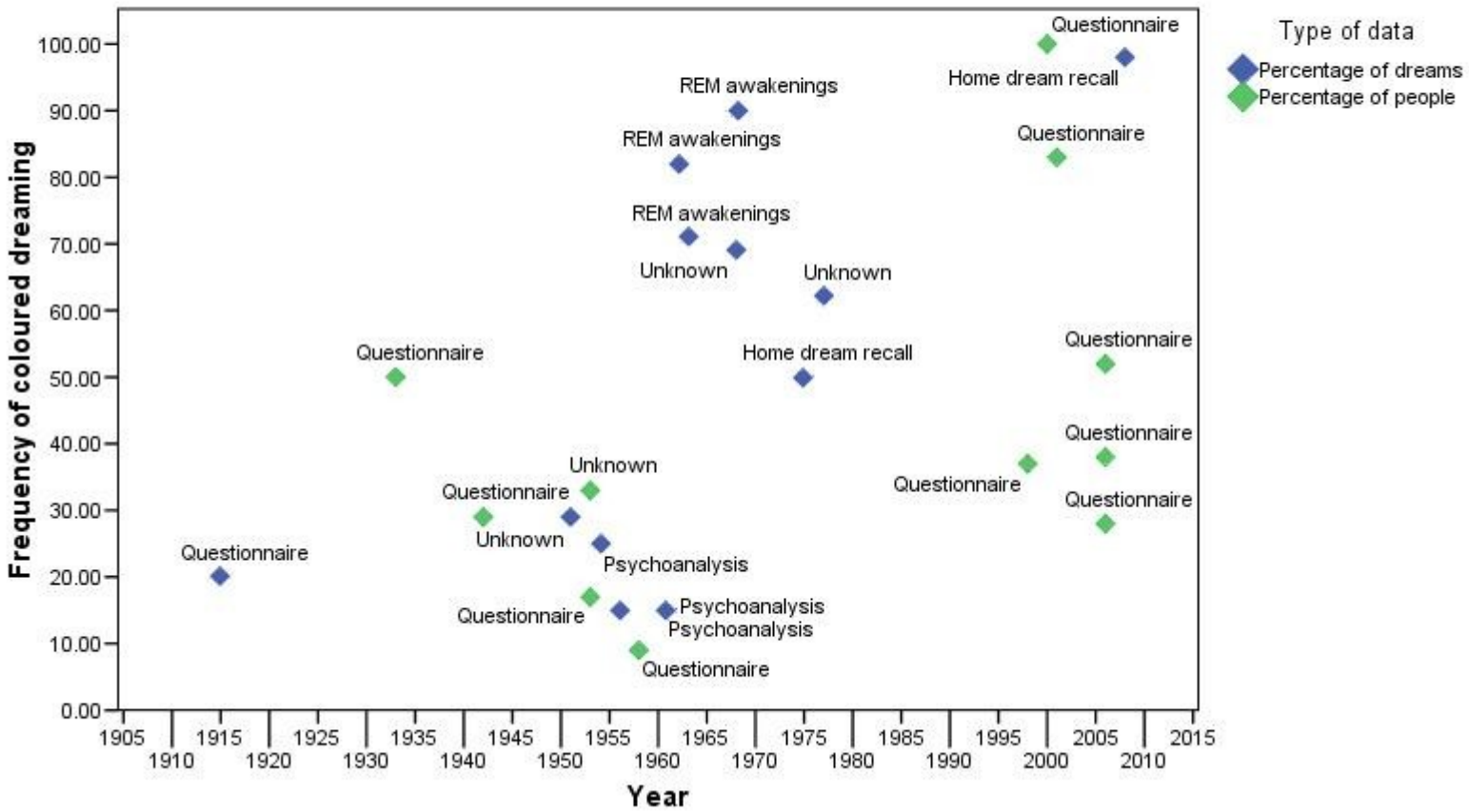


Figure 2: Frequency of coloured dreaming across the 20th century

CHAPTER 3: HISTORICAL FACTORS IN GREYSCALE DREAMING

This chapter introduces two main explanations for the historical incidents of greyscale dreaming, namely the presence of black and white media and the methodological differences between the studies in early and late 20th century. The discussion of the media influence first presents the historical and geographical interplay between media access and dream colour and then introduces the mechanisms that explain how media could influence dream reports and then the dream experience itself. The review of methodological contributions to dream colour focuses on the various ways of gathering data on dream colour and then highlights the cognitive mechanisms that are behind the differences in the quality of data obtained through these methods.

3.1 Black and white media

Possibly the most controversial factor that could have prompted so many people to report greyscale dreams is black and white media. The years in which greyscale dreaming was most frequently reported highly coincide with the years of highest popularity of black and white media. The first publicly screened 'movies' – ten short films by Auguste and Louis Lumiere – were created in 1895, and by the time Bentley (1915) had carried out his first study, over 20 new black and white feature films were produced every year. It was very likely that the average college student (the most often used participant in these studies) had regular contact with black and white cinema. In the 1930's and 1940's few people owned a TV set, but there were plenty of opportunities to see the movies at the cinemas, especially in the

relatively well-//off USA, where most of the studies were carried out. The rise in coloured dreaming, on the other hand, coincides with the rise of coloured media – initially colourised with Technicolor, and then created using colour reel technology. Although the first attempts at producing colour movies happened as early as 1895 (Edison's hand-painted '*Anabelle's Dance'*), and occasional colour movies were produced throughout the 1930's and 1940's they were not as widespread as black and white movies. It was only in late 1940's that colour movies began to dominate and by late 1960, nearly all movies were produced in colour. As far as television is concerned, the first colour TV shows were broadcast in 1950 for viewing on publicly available screens – the first consumer colour TV sets appeared in 1954 and by 1972 majority of USA households had a colour TV. When the development of colour media is charted alongside the estimates of colour dreaming frequency, the convergence is striking – the only discrepancy is the slight delay between the popularisation of coloured media throughout the 1950's and the first studies that yielded the high colour reports from the 1960's. The fact that there were no reports of greyscale dreams before the introduction of cinema (and interestingly, black and white photography did not seem to have this effect) is a strong supporting point for the influence of black and white media on how people reported their dream colour. The idea that black and white media might be the cause of achromatic dream reporting is also strengthened by the two outlier studies from 1998 and 2006. Stepansky et al (1998) found that 37% of their diverse Austrian sample reported dreaming in colour, and that there were age differences in the frequency of coloured dreams, with the older age groups reporting less coloured dreams than people under 30 years of age. The high rate of greyscale dreaming in the older generation is consistent with what would be expected if they had their dreams shaped by black and white media – which would be the case in Austria, as the time and speed of introduction of coloured media were substantially slower

in Europe after 2nd World War than in the prosperous USA. Even a lot of the people in the 30-50 age range can be expected to have had frequent contact with black and white television in their youths. The main problems with this interpretation lies in the possibility of age differences imitating the effect of black and white media, because ageing affects dream recall and memory (a detailed discussion of how age changes might impact reported dream colour is in chapter 4). Therefore, a cross-sectional study cannot provide conclusive evidence for the influence of media without investigating how the above mentioned ageing issues might affect the recall of colour in dreams. The second study, carried out by Schwitzgebel et al. (2006), circumvented that problem by comparing three similarly aged populations from different regions in China, which had different levels of access to technology, including coloured media. They found that the levels of reporting of coloured dreaming were directly tied to the access to coloured media the respondents had: coloured dreaming was most prevalent in the technologically advanced group (52% reporting colours at least occasionally) and was lower in the intermediate group (38%) and the least advanced group (29%). The least technologically advanced group had also the highest rate of reporting of black and white dreams (22%, compared to 9-10% in the more advanced groups). Interestingly, while media-related differences were found between these three groups, there were no within-group relationships between individual media experience and their dreaming patterns. The authors suggested that this could be due to dream reporting being more influenced by the culture specific to a given group than by any individual differences in media experience. Figure 3 on page 20 shows how the timeline of media colour overlaps with the timeline of dream colour in the 20th century.

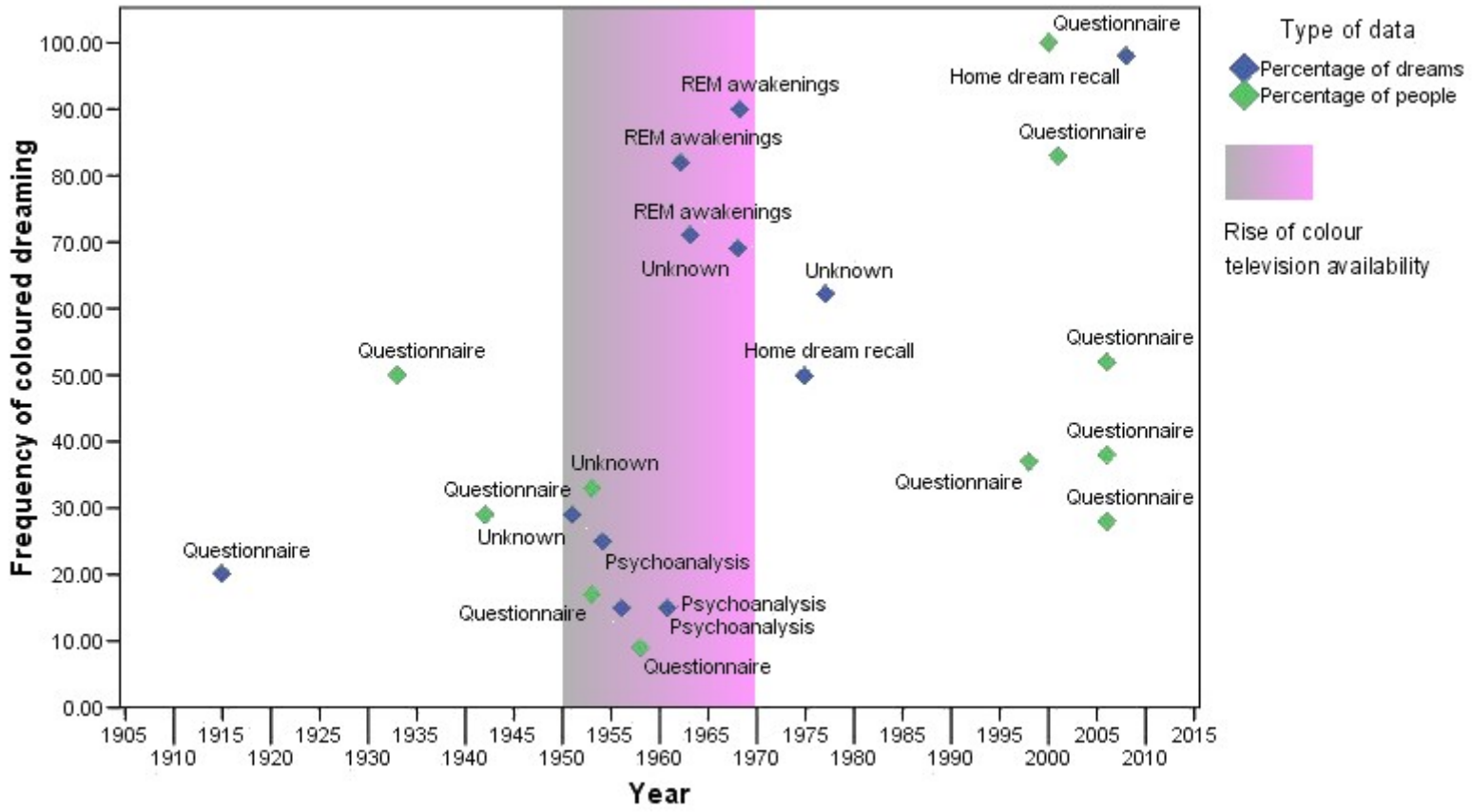


Figure 3: Comparison of the dream colour timeline with the popular introduction of coloured television

As this historical and geographical parallel unfolds, it is important to keep in mind that the correlation does not signify causation. As people gained access to black and white and then colour media, their lives were changing in a variety of other fields. While there is currently no other environmental element that could be pointed at as an alternative cause (though the bleakness of the industrialisation is sometimes jokingly mentioned as such a factor), providing a plausible mechanism for how media could impact the dream reports is a necessity. The dream immutability and achromatic dreaming theories only have to present evidence for how access to black and white media might have prompted people to report greyscale dreams, without any assumptions regarding the actual colour of the dream experience, and they can do so by invoking social pressure and expectations. The dream shift theory has to provide a plausible explanation for how visual media could impact the dream experience itself, and the main candidate for this theory is the Continuity Theory, along with the power of social expectations to change the nature of mental experience.

3.1.1 Explanations of media impact on dream experience and recall – cultural milieu

The simplest way in which black and white media might have influenced dreams (both the reports and experience) is through setting up a monochrome cultural model of dreaming. Cross-cultural studies of dreaming have found that dream content, and the form in which dreams come is regulated by the local beliefs about the function and meaning of dreams. For example, the Triobrand people did not report anything resembling our ‘free dreaming’, and only spoke of ‘official dreams’ that ran along prescribed lines: fishermen dreamt about the weather at sea and the locations of fish; expecting mothers had dreams of ancestors announcing the arrival of the child (Malinowski, 1974). In the Native American tribes, prescribed dreams that would uncover the future or direct the dreamer towards their social

role were often sought through the usage of ceremonies and fasting (Lincoln, 1935). In ancient Greece, prescribed dreams would be 'seen' in places of worship, such as the temple of Asklepios, where pilgrims would come to experience dreams that would inform them about the nature of their ailment and the way of curing it (Oberhelman, 1981). In our culture, black and white movies provided a useful way of thinking about dreaming: dreams are highly visual and emotionally involving narratives – and so are movies. Although we do not star in movies, we do get emotionally involved in the plot and the camera allows the viewer to take the point of view of one of the participants, rather than a completely external observer. The fact that we cannot influence the way the movie proceeds can feel similar to the 'observer' quality of many of the dreams, where things happen but there is no feeling of decision making. Finally, movies also presented accounts of dreaming – in slightly washed out and blurry greyscale. Very soon, movies became a valid and useful metaphor when talking about dreaming; and dreams-as-movies played in our mind's eye were frequently mentioned even in research literature (Hall, 1953, p.3).

One major problem lies in the fact that it is often impossible to determine whether such culturally prescribed dream reports actually reflect the genuine dream life of people, or they are tailored by the dreamers post-factum to suit the expectations of the culture. This objection concerns the prescribed dreaming in primitive cultures just as well as greyscale dreaming. Therefore, two possibilities have to be considered. In the first option, black and white media acted as a conceptual scaffold over which dreams were built, shifting the visual elements of dreaming into greyscale. The human mind is flexible and shaped by the cultural background – occurrences such as hysteric conversion or Koro are clear examples of how beliefs about what is true and appropriate can have a deep impact on bodily and mental function (see Simons and Hughes, 1985, for a comprehensive list of culturally specific mental

states and illnesses). The case for greyscale dreaming can be made by invoking similar mechanisms as in the other culture-bound phenomena. If black and white media were pervasive and persuasive enough, the beliefs about what type of dreams is proper could trigger these types of dreaming.

The second, more conservative approach states that the presence of black and white media only created an environment that made it easier to ignore incidents of coloured dreaming and to misinterpret poorly recalled dreams as greyscale. This explanation is much simpler than the previous one as it does not invoke any rare psychological processes and treats dream reporting as any other communication type in which people are under a social pressure to conform. Because of this simplicity, it is the null hypothesis of media impact – if media access is indeed correlated with dream colour this is the most obvious explanation that is assumed by most researchers. On the other hand, the main advantage of the former explanation is that it does account for the longevity of media influence. Stepansky et al. (1998) found that older people report more greyscale dreams, which barring any memory problems, would be consistent with the idea that exposure to black and white media produces a change in reported dream colour. The latter approach is at a loss when it comes to explaining why a brief period of external pressure to report greyscale dreams would leave an impact that is detectable years (or decades) after colour media became the ideal and the norm.

3.1.2 Explanations of media impact on dream experience – continuity theory

The second main way of accounting for the impact of media is directed specifically at explaining how television could genuinely change the dream colour, and the main theoretical candidate that could offer such an explanation is the continuity theory. According to the continuity theory, the majority of dreaming instead of being bizarre and detached from life is

actually modelled on everyday experiences and situations. This theory has garnered a lot of empirical support and is currently one of the major driving forces behind dream research. While the correspondence between unique everyday events and their coherent incorporations in dreams ranges from moderate to weak (Nielsen, Kuiken, Alain, Stenstrom and Powell, 2004), there is robust support in the research literature for the replication of the general pattern of people's activities and environment experienced during the day in dreaming. For example, the dreams of sportspeople include a lot of sports activity (Erlacher and Schredl, 2004) and dreams contain references to the activities prominent in the current seasons (Schredl, 2004). There are some exceptions to this rule – despite spending a large proportion of our time reading and writing (or doing other convergent thinking tasks), these activities very rarely show up in dreams (Schredl and Hofmann, 2003; Schwartz, 2003). More importantly, watching TV is also underrepresented in dreaming, although not as strongly as the previously mentioned cognitive tasks. On the surface, the existing research on content continuity does not give the black and white media influence a good foothold - the majority of our visual experience with the world is in colour and a few hours of black and white TV in a day (or even as little as a few hours of black and white cinema in a week) should not have a serious impact on dreaming. While there is evidence that unusual material with high emotional involvement get incorporated into dreams more frequently than everyday, mundane activities (Schredl, 2003); and it can be argued that movies do fulfil these criteria (especially if the novelty of cinema in the early 20th century is considered), the overall rate of movie incorporation into dreams seems too low to explain the high incidence of black and white dreams (Arkin and Antrobus, 1991)

When the continuity between the waking and dreaming visual experience (as opposed to content incorporation) is investigated, the evidence that could support the idea that black and

white media influenced dream colour is rather modest.. In one study (De Koninck, Prevost and Lortie-Lussier, 1996) participants wore special prismatic goggles that vertically inverted the visual field. After up to 4 days of wearing these goggles, incorporations of visual inversions occurred in half of the subjects (who, incidentally, also tended to perform better on waking adaptation tests) and the incorporations were only visible in elements of the dream – no completely inverted dreams occurred. Another study had the participants wear red-tinted goggles (Roffwarg, Herman, Bowe-Anders and Tauber, 1978) throughout all of their waking hours for several days. When the sleep laboratory dreams were examined for incorporations, it turned out that the perceptual effect had been carried over to REM sleep reports – the participants were reporting more red and fewer other colours. Moreover, the red shift was observed for dreams with memory sources predating the experiment.

While both of these experiments suggest that sustained modification of the visual field will result in corresponding changes in the dream visual experiences, it is still highly debatable whether black and white media could play such a role for dreams. In the studies, the visual field was modified for the whole duration of waking hours for a few consecutive days, while people typically only had contact with black and white media for up to a few hours in a day. Moreover, the vertical inversion goggles and the red goggles affected the whole visual field, and both television and cinema always leave peripheral visual field unchanged, and allow for free eye movements to colour surroundings. Finally, both of the studies only investigated the first few days of visual field modification. Dreaming has been implicated as a mechanism of adaptation to novel activities (Kuriyama, Stickgold and Walker, 2004; Schredl and Erlacher, 2007), and there is a possibility that the visual incorporations would disappear after a longer time of wearing the goggles.

To conclude, the available evidence from the continuity theory research does not provide a satisfactory mechanism for how black and white media might have influenced the colour of dreams. While there is no evidence to the contrary, the existing studies do not demonstrate unequivocally that the continuity hypothesis could alone account for the strong and lengthy change in people's dream colour. It is, however, possible that the mechanisms of cultural pressure described in the previous subsection could interact with continuity, strengthening the impact of media disproportionately. This prospect has not been explored in any of the studies that investigated continuity – neither of the visual modification studies, for example, used a type of visual field transformation that would tap into popular beliefs about how dreams should look like. Indeed, it would be currently hard to find a parallel to black and white media that could serve this role (perhaps with the exception of virtual reality and computer games for the younger generation).

3.2 Methodology

The second main factor presented as an explanation for the period of greyscale dreams are the methodological differences between early and late 20th century studies. In 1953 Aserinsky and Kleitman revolutionised dream research by discovering REM sleep and establishing the connection between REM sleep and reliable dream recall. The earlier studies that investigated dream recall all relied on questionnaires, dream diaries or daytime dream reports to draw conclusions about the colour of dreams. The later studies made use of the technique of REM awakenings, where a person is woken up after a few minutes of REM sleep, and thus can report the contents of their dream immediately. Figure 4 on page 27 shows the overlap between the introduction of the new method and the timeline of colour dreaming.

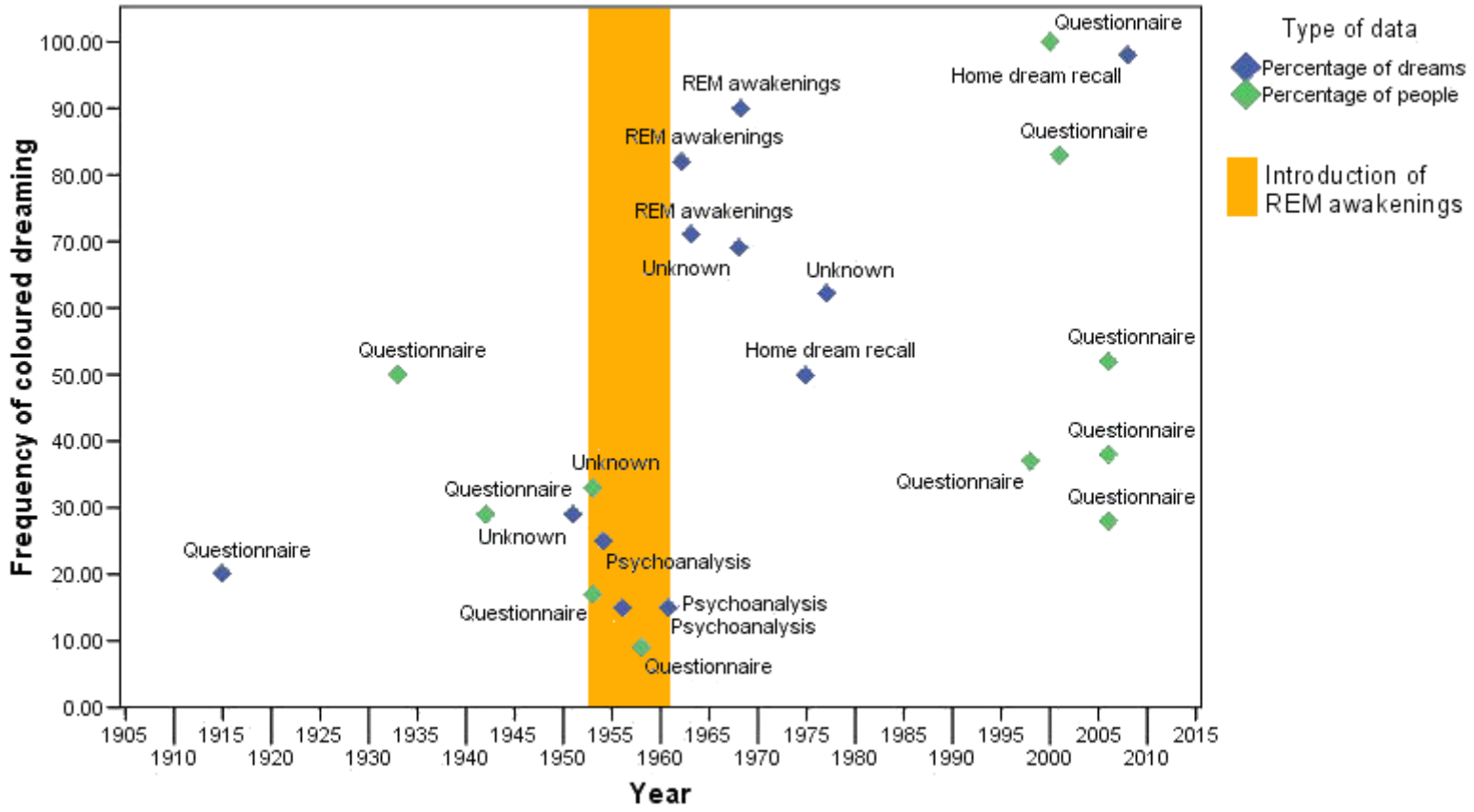


Figure 4: Overlap between the timeline of coloured dreams and introduction of REM awakening method

This methodological difference introduces two possible sources of disparity in the data gathered: time elapsed between dream and recall and the way in which the dreams are sampled. The sampling issue stems from the fact that while we dream many times during the night (if not constantly), we only recall a fraction of our sleep mentation – and some dream gathering methods probe different fractions of the dream experience. The time between the dream and recall in the dream journal/dream telling cases can range from a few minutes to a few days or months– much longer than in the case of REM awakenings. Moreover, in a sleep laboratory situation, the participant is woken up and immediately given an explicit instruction to report what was going on in their mind before awakening, while in a home situation the immediacy, or the success, of the dream report (or private recall) depends on factors such as external interference, other life concerns and the attention devoted to remembering the fleeting dream content (Cohen, 1974). Below, I will discuss these factors in more detail.

3.2.1 Typicality of recalled dreams

One way in which the diary/questionnaire dreams and dream reports from the sleep lab can differ is by the representativeness and typicality. Because of how REM sleep neurobiology works, it is almost impossible to form memory traces while dreaming (Hobson, Pace-Schott and Stickgold, 2000). Therefore, only dreams from which a person woke up, even if briefly and incompletely, can be still grasped from short term memory and encoded. As a result, there is a 80-90% dream recall rate from REM awakenings (Nielsen, 2000), which means that typically a person has around 4-5 REM dreams per night while the average diary dream recall frequency for adults is only 2 per week (Belicki, 1986; Schredl, 2003). Thus, in REM awakening studies the participants are recalling almost every REM dream they had, and in the diary method only a select few. This can lead to a distortion of what kinds of dreams are

reported in home dream diaries. One of the factors behind dream recall is dream memorability – and there is a possibility that the dreams that are recalled for dream diary and questionnaire studies are more memorable, vivid and intense than the average REM dreams. This distortion should work however in favour of coloured dream reporting, as coloured and visually detailed dreams should be more salient and memorable (the role of colour in memory is discussed in section 4.2.1), and thus should be over-represented in home recall conditions. On the other hand, it could be argued that if greyscale dreams were indeed modelled on black and white movies, which are in themselves very emotionally intense and salient, these colourless dreams should be proportioanlly more frequency in home dream recall. The available research, however, suggest that dream recency and length are more important in dream recall than salience is (Domhoff, 2003). Unless morning dreams (typically picked up by dream diaries and most recent dream paradigms) have a tendency to feature less colours than night dreams – which seems unlikely – the properties of the REM dreams reported in diaries and sleep lab studies should not be a factor in the differences in the reporting of colour in dreams between early dream diaries and later REM awakening studies.

The disparity in the sampling between the home and laboratory dream reports can however be used in favour of home recall reliability. In the majority of the sleep laboratory studies only REM dreams are investigated. However, dreaming also happens in the non-REM stages of sleep (Nielsen, 2000), although it is less vivid and bizarre and more ruminative and mundane than the typical REM dreams are. The smaller brain activation present in NREM sleep can conceivably lead to dreams that are colourless or otherwise visually impoverished (See Chapter 3 for a detailed discussion of the neurological basis of greyscale dreaming). It seems plausible that home dream recall might include some NREM dream reports alongside the usual REM ones, which could partially explain the discrepancy between the results of

home dream recall studies (that had uncovered high rates of greyscale dreaming) and REM awakening studies (with typically high rates of colour in dreams). It has to be mentioned, however, that there are a few recent home recall studies that have yielded very high rates of colour recall from dreams (Schredl 2008) so the possible differences between the REM/NREM dreams proportions between sleep laboratory and home recall studies cannot account for a lot of the variance.

3.2.2 Memory factors

The time delay between the dream and the reporting of its content is a powerful factor in the recall of dreaming because it forces researchers to consider memory as a factor in dream recall. There are three interacting processes that operate within memory systems that have the potential to make questionnaires less reliable than morning dream recall, and morning dream recall less reliable than REM awakening dream reports. These are memory interference, retrieval problems and memory reconstruction.

Memory interference refers to the process in which more recent information pushes older data out of working memory, preventing the proper encoding of the material into long term memory. Interference is one of the key factors in dream recall – dreams are not easily encoded in sleep and the thoughts and stimuli experienced on awakening can push the dream content out of the working memory. This problem is averted in REM awakenings, since the first thing the person hears upon being awakened is a query for the content of the dream. Additionally, the external stimulation is kept to a minimum, so that there are as few sensations interfering with the dream content. In home dream recall the pressure of the new day often diverts the dreamers thoughts from the dream; and either removes the possibility of dream recall completely or severely reduce the details available from the dream. In fact, a lot of

the self-training books on improving dream recall target this mechanism and advise the dreamers to focus on the memory traces of the dream immediately upon awakening.

The second type of memory problems relate to the situations in which the dream has been encoded in long term memory, but the dreamer cannot retrieve the memories. This happens if there are not enough cues available to activate the correct dream memory or when the context of the recall is different from the context in which the memory was formed (Tulving and Thomson, 1973). Once again, sleep laboratory studies have the advantage of providing a strong recall cue – the verbal instruction to report the dream – immediately upon awakening, and the reporting process happens in a dark room, while still in bed. Home dream recall is also conducive to strong thematic cues (since dreams are connected to waking life, various waking events can serve as cues for recall) as suggested by the phenomenon of midday dream recall. However, it is still much lower than the recall rate for REM awakenings, and the fact that the cues do come from waking life might mean that bizarre dreams with no waking life references might be under-represented in home dream recall.

Finally, there is the issue of memory reconstruction: memories are surprisingly malleable (Loftus, 1995 and 1996) and can be modified or even manufactured with the appropriate external influence or internal motivations. After the dream experience happens, the dream memory can change whenever the dream is recalled, whether it is for private enjoyment or when prompted by a researcher. Subtle cues introduced through the way questions about dream colour are asked can potentially lead to distortions in the reporting of colour and the increased time frame between experience and recall makes more space for memory revisions to occur. While it is hard to reconstruct how the relevant questions were asked, there are some clues that the approach to coloured dreaming the early 20th century could have subtly discouraged people from recalling colour. Coloured dreaming was first seen

as an oddity in the 30's and 40's (investigated en par with coloured hearing by Middleton, 1942), and later it was considered a sign of possible psychiatric problems in the late 1950's (Tapia et al, 1958). The psychoanalytic theories about the meaning of colour in dreams were also not entirely encouraging – the pathologisation of coloured dreaming started appearing in the 1950's, with Calef's (1954) treatise on colour in dreams as a display of exhibitionist, excremental and regressive tendencies. It is quite understandable that with this sort of pressure people would be reluctant to share the fact that they do, in fact, dream in colour, and would be more likely to ignore and forget such dreams. Whether the cues provided by the researchers or therapists could fully account for the sizeable differences in dream colour reporting between early and late studies is, however, uncertain. A good explanation for why researchers would suddenly begin to expect a different pattern of dream colour would have to be provided for this explanation to be completely credible. The influence of black and white media and the later introduction of coloured media, as discussed previously, is one good candidate for the external reason for why the popular views on dreaming could change, but the question whether it could have influenced the researchers remains open. Overall, it seems that the stigmatisation of colour in dreams could explain how the high rate of greyscale dreaming was maintained between 1915 and 1950's, but it cannot explain why so many people started to report such dreams in the first place.

One of the overlooked issues is that currently there might be a pressure not to report black and white dreaming. During the 20th century, the role of dreaming has grown from personal and diagnostic (in psychoanalysis) to a spiritual and creative, as evidenced by the numerous interest groups and books on the power of dreams. Interestingly, the shift in dream value has happened mostly during the 1960's – precisely when reports of frequent coloured dreaming begun to appear. Nowadays, when achromatic dreaming is discussed in

popular media (or in private conversations), it is often treated as a worse type of dreaming, one that is somehow deficient – like black and white TV. It is plausible that some people might be under-reporting the incidence of greyscale dreams to avoid labelling themselves as deficient. Therefore, just as caution is needed when analysing old reports of black and white dreaming, the issue of a culturally-induced reporting bias should also be taken into consideration when analysing modern dream reports.

3.2.3 Questionnaire dream judgements

The sections above mostly discuss the differences between the data gathered from home dream recall and the sleep laboratory – but the questionnaire method of investigating dream colour has its own problems in addition to issues involving time delay and recall selectivity. In a questionnaire study of dream colour (such as one by Middleton, 1942) the participants are typically asked to estimate whether they dream in colour or black and white, and to provide an approximation of the frequency of the coloured dreams. The reliability of questionnaire data thus hinges on the participant's introspective ability and the ability to form accurate judgements about the frequency of particular mental events. Very few people take an active interest in their dreams and have access to their systematic dream records – therefore dream colour questionnaires are typically filled out basing on the few most recent, or the most memorable dreams. As a result, questionnaires can paint a very unreliable picture of dream colour. Even more problematically, people can simply go along with what they believe is the appropriate way of answering this question. When Bernstein and Belicki (1995) compared people's opinions on the amount of friendly, aggressive and sexual interactions in their dreams to the actual dream diary measures of these types of content, they

found that there was a negative correlation between the two rankings. The participants said that they have most dreams with friendly interactions, then sexual and in the end, aggressive, while the dream diary ranking was aggressive first, then friendly, then sexual. The fact that the early studies of dream colour were largely based on questionnaire data yields credibility to the hypothesis that the chosen method of inquiry (along with the operation of social biases) could account for the high rates of greyscale dream reporting in questionnaires.

However, none of these arguments can be used as the definitive explanation for greyscale dreaming. Questionnaires have also been used more recently (Schwitzgebel, 2003) and they yielded completely different results from the previous ones – in the early 21st century people massively tend to report coloured dreaming regardless of the method used. Home dream recall has also yielded different rates of colour dreaming in the early 20th and 21st t century (compare the results of Knapp, 1956 and Schredl, 2008). The possibility of pressure to report colour dreaming has been mentioned in the previous section, and should always be considered as a factor – if there is a proportion of dreams that is recalled without sufficient colour details, they can be interpreted as colour dreams if the natural template for dreaming is colour. This way, poor methodology works as a catalyst for bias, which works regardless of whether the prevailing social opinion of dreams understands them as colour or geryscale. Finally, the first REM awakening studies in the 1960's estimated the proportion of coloured dreams at 70%, and raised their estimates to 100% in the following years. If methodology was the sole cause of greyscale dream reports, a much sharper increase (to almost 100%) would be expected.

3.3 Summary

This chapter summarised the two historical factors that were possible contributors to the wave of greyscale dream reports in the early 20th century. The evidence for the impact of

black and white media on dream reports seems compelling due to the close time match between the timeline of black and white media popularity and the rise and fall of greyscale dreams. The geographical and generational distribution of greyscale dreaming is also a strong point in favour of this explanation. Nonetheless, because the potential mechanisms through which media could influence dreams are not well explored, only the weaker version of black and white media influence can be supported in this review: contact with black and white media might have caused people to report greyscale dreams without necessarily creating the greyscale dream experience.

The methodology explanation on the other hand is quite elegant and parsimonious, as it rests on well defined memory and bias mechanisms that have been explored in different areas of psychology. However, it cannot fully account for the trends in historical and contemporary distribution of greyscale dream reporting. More specifically, it cannot account for why people would start to report greyscale dreams, since before the early 20th century people reported colour dreaming with the same simple data collection methods. It also cannot explain why colour dreaming was on decline until 1960's and why the rebound after REM awakenings were introduced did not reach 100% immediately. Moreover, when detailed comparisons of REM awakenings and home dream recall are made (and pursued further in chapter 5), it becomes visible that home dream recall is much more reliable and representative than the methodology hypothesis assumes. Both the media and methodology explanations can interact, since it is much easier to misinterpret dreams as greyscale if a widespread social belief about the colourless nature of dreams exists.

The evidence presented through the media and methodology approaches is currently more in line with the achromatic and immutable dream theories: both of these theories rely on simple and parsimonious ways of explaining why people would suddenly start reporting

greyscale dreams. The dream shift theory, on the other hand, has to reach for more complex mechanisms of change – and extraordinary claims require extraordinary evidence. Figure 5 below shows a summary of the factors that were though to impact the reported dream colour in the early 20th century.

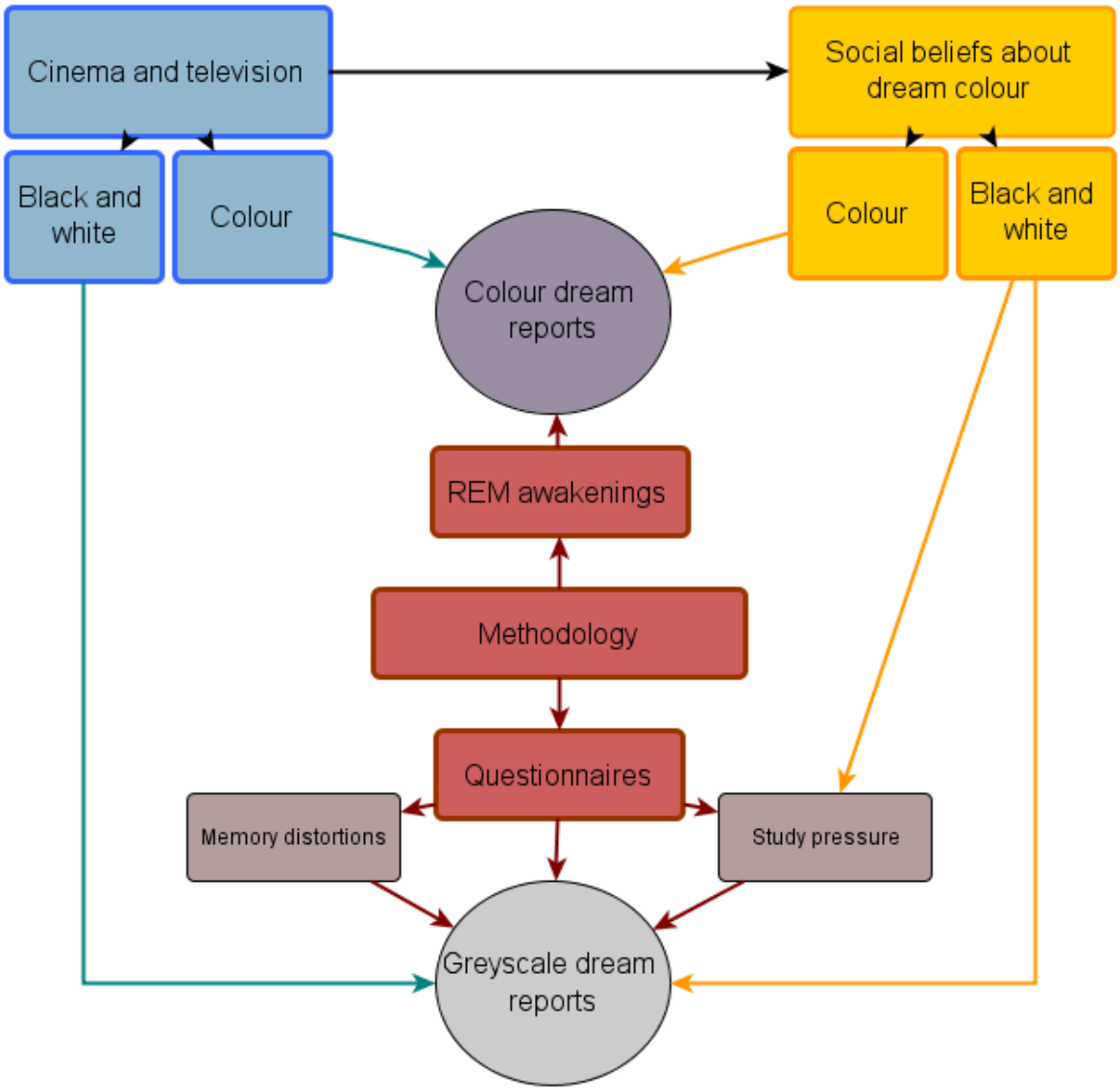


Figure 5: The impact of black and white media and methodology used on reported dream colour.

CHAPTER 4: INDIVIDUAL DIFFERENCES IN COLOUR OF DREAMS

The previous chapter presented the factors that might be responsible for the sudden shift in how people were reporting the colour of their dreams. There is another dimension to both historical and current data on dream colour that needs to be addressed – all of the studies have demonstrated individual variability in the reported dream colour. Even in the modern studies we find that the rate of colour recall in dream is not 100% and we do not know what is causing some people to report fewer coloured dreams than others. Investigating the individual differences in greyscale dreaming might shed more light on the historical differences – explaining the antecedents of individual variation in the form of dreams could help account for why some people would be more susceptible to the mechanisms discussed in the previous chapter. The potential factors that could play such a role are neurological and cognitive in nature – the former address how colour experiences (in vision and imagery) is produced in the brain, and the latter invoke the properties of memory and visual imagery and apply them to dreaming. Age as a potential factor behind the outlier Austrian study (Stepansky et al. 1998) is also discussed.

4.1 Neurological factors

The best understood reason for colourless dreaming is neurological in origin. The part of the extrastriatal (secondary) visual cortex that is tasked with colour perception is known as the V4 region in the occipital lobes. Research carried out with macaques (Zeki, 1973) has shown it to be responsible for the processing of colour and shape information from

the primary visual cortex. In humans, electromagnetic stimulation of the V4 region results in the subjective experience of colour in the form of 'chromatophenes' – coloured auras and circles that appear floating in the visual field and are often encountered in migraine aura (Sacks, 1995). In healthy humans, the extrastriatal visual cortex (containing V4 and other secondary visual areas) is highly active during REM sleep, providing a neurological basis for dreams that are rich in visual elements and granting at least the neurological potential for colour experiences during sleep. Some researchers have tried to match the qualities of the V4 region with particularities of dream visual experience. For example, Padgham (1975) found that in a sample of 49 dreams taken from 6 participants there was a relative paucity of blue, and a lot of the more intense colours were in the orange-red spectrum. This was later supported by Jankowski, Dee and Cartwright (1977), who also found that the most saturated colours in their dream sample (taken from REM awakenings) were in the orange-red spectrum. Padgham linked that with the fact that V4 cortex is particularly sensitive to red – 10 out of 11 units of the cortex respond to red, while only one unit responds to blue (Zeki, 1973). Middleton (1942) also found that when colour in dreams was reported by his respondents, it was frequently the colour of fire, and that many people could only recall red from their dreams. Because stimulation of V4 region does result in floating colour hallucinations, there is a legitimate line of research in finding out what colours are most prominent in dream reports and whether they match up with the neurological predictions.

When the V4 area is selectively damaged (or is temporarily inhibited by magnetic stimulation; Sacks, 1995), the resulting condition is known as achromatopsia and is characterised by complete lack of colour vision (everything presents itself in shades of black, white and grey) accompanied by a complete inability to imagine colour and a profound loss of all colour sensations in dreams (Sacks, 1995, Solms, 1998). Since this type of brain injury is

exceedingly rare, it is difficult to argue that achromatic dreaming can be explained by people suffering mass achromatopsia upon falling asleep. Interesting supporting evidence from brain tumour studies (Brodal, 1981) suggests that when selective loss of vision is caused by pressure on the nerves, colour perception is the first aspect of vision that is lost, and the last one that is regained when the pressure is removed. Because of this relative vulnerability of colour vision, and the fact that colour is not essential for visual experiences, it is possible that in some less activated dreams the V4 cortical area responsible for colour vision does not participate in creation of the dream, resulting in colourless dreaming. Non REM dreams that arise within a less activated brain state are prime examples of sleep mental activity where such colourless dreaming might occur. To summarise, while there is no evidence that the period of greyscale dreaming in the early 20th century could be caused by a mass neurological disturbance, the neurology of colour perception and imagery suggests a plausible source of individual differences in dream colour.

4.2 Visual memory

One of the cognitive factors that might play a role in greyscale dreaming is visual memory. Being able to remember detailed visual information should be conductive to a more reliable assessment of dream colour – and thus researching visual memory could be a way to find out if greyscale dreams are an actual experience or a memory artefact. Visual memory has already been found to influence home dream recall frequency (Schredl and Montasser, 1996-7): people with good visual memory do recall more dreams than people with poor visual memory. Schredl, Frauscher and Shendi (1995) established that visual memory, measured was positively related to dream recall frequency. In a later study Schredl, Jochum and Souguenet (1997) confirmed that self-assessed dream recall frequency was moderately correlated with 3

measures of visual memory – self assessed, map reproduction and image memory. Good visual memory might also increase the completeness of dream reporting, although Schredl et al. (1995) did not find a correlation between visual memory and dream report length. However, no research has been done on the possible relationship between visual memory and the visual features present in the dream reports. When greyscale dreaming is taken under consideration, it seems reasonable that having poor visual memory could lead to an underreporting of colour experiences within a dream. Recalling the red colour of a car is contingent on being able to remember that there was a car there in the first place.

Before the impact of visual memory on dream colour is investigated, the methodological issues with the existing studies need to be commented on. Practically all of the studies on visual memory use directed tasks, in which the participants are aware that their memory is being tested. In such a situation people can make an effort to remember as many visual details as they can. With the rare exception of lucid dreaming, people do not make such a conscious mental effort to recall the visual details during the dream. Therefore, when the influence of visual memory on dream colour is investigated, using a more naturalistic approach and measuring incidental visual recall would possibly yield more valid results.

4.2.1 Memory for colour

A more narrow skill within visual memory that could be responsible for the individual differences in the reported colour of dreams is memory for colour. While good visual memory might influence the number of general visual details in the dream report, colour memory should allow the dreamer to supply more precise colour descriptions. While there are currently no studies that look at colour memory and dreaming, there are a few studies that

deal with the general reliability of colour memory, and the evidence from this research is very mixed. (Park and Mason, 1982) found that adults perform at chance levels when recalling if a slide they saw was red or green, and Park and James (1983) found a similar result in children. On the other hand, a few more recent studies (Bäckman, Nilsson and Nourp, 1993; Hartwell, 1995; Ling and Blades, 1996) discovered that incidental memory for the colours of objects and pictures can be quite accurate both in children and adults. Crucially for the current research question, none of these studies were investigating people's ability to remember if they were watching colour or black and white images, which would be the main issue in the recall of greyscale dreams. An interesting question that arises is whether people are better at remembering the presence or absence of colour than they are at trying to remember the particular colours – after all it should be easier to remember just the presence of any colour. This issue has not yet been addressed in any research, creating an avenue for establishing whether individual differences in memory for presence of colour can be linked to the individual differences in dream colour.

Before such a link is made, however, it is important to mention that colour itself has an influence on visual memory. The presence of colour in visual stimuli (such as pictures) improves later recognition of the images (Spence et al, 2006; Suzuki & Takahashi, 1997). This effect is located in the encoding stage and colour is understood to play the role of additional detail which facilitates encoding and later retrieval through multiple cues. The consequences of this mechanism for dream colour are complicated. On one hand, it should increase the rate of recall for colour dreams by supporting the recall of dream visual images. On the other hand, it might lead to an under-reporting of greyscale dreams, which would be more difficult to recall due to fewer cues present in them. The second option is most probably not true, since if that were the case, REM awakenings should increase

the individual's rate of greyscale dream reporting as compared to home dream recall – which is not what can be seen in the available data. Admittedly, there are no studies that compare the rates of dream colour obtained using REM awakenings and home dream recall for the same participants. Additionally, the small sample sizes that usually used in REM awakening studies (due to the high cost of research) do not contribute to the generalisability of dream colour data received from those studies. If only a small percentage of the population experience genuine greyscale dreams, the chances of including such a person in a REM study without specifically advertising for them is probably very low. Thus, it is somewhat difficult to compare the validity of dream colour data gathered from REM awakening studies and from home recall approaches.

4.3 Visual imagery abilities

Visual mental imagery refers to the ability to 'see things with the mind's eye' or more precisely, to a 'a set of representations that gives rise to the experience of viewing a stimulus in the absence of appropriate sensory input' (Kosslyn, 1994, p.334). Neurological research has that Brodmann areas 17 and 18 in the occipital cortex (area 17 being the primary visual cortex and area 18 the extrastriate visual cortex) are usually active during tasks that require visual imagery (Kosslyn, 1994). The activation patterns are in fact quite similar to those generated during normal perception and both of these areas are also highly activated during REM sleep (Hobson and Pace-Schott, 2002; Maquet, 2000). Therefore, it seems reasonable (and parsimonious) to conclude that dream visual experiences are formed through the same mechanisms as our waking imagery is constructed. Existing research has already linked good visual imagery skills with higher dream recall: Hiscock and Cohen (1973) found that frequent

dream recallers had better scores on Gordon test of image controllability (Gordon, 1949), scored higher on Bett's visual scale (Richardson, 1969) and showed a stronger influence of visual imagery instructions in a paired associate learning task than low dream recallers.

There are two ways to explain this correlation. A stronger hypothesis states that people with poor visual imagery skills simply experience fewer dreams. While there are no REM awakening studies that investigate dream recall and visual imagery, there is some neurological evidence that one component of visual imagery, namely spatial imagery, is a necessary factor for the experience of dreaming. In his extended study of neurological hospital patients Solms (1999) found that bilateral lesions to the parietal cortex (particularly the spatial orientation areas) were often linked with a complete cessation of dreaming. Moreover, Foulkes (1999) had also found that children's dreams develop in line with their spatial reasoning and imagery, and not verbal ability as was previously expected. Children with a specific spatial imagery deficit had fewer dreams than normally developing children and their dreams were less complex. Whether these neurological and developmental findings can be applied to a normal adult population remains to be seen, but this theory does provide an opportunity to look at the phenomenon of greyscale dreaming from a new angle. The second explanation for the positive correlation between imagery and dream recall rests on dream recallability. If people with good visual imagery skills, who can visualise objects and scenes in great detail, are able to generate their dreams with more visual details and more vivid and clear imagery, it is possible that their dreams will be more salient and easily remembered in the morning. Conversely, people with poor visual imagery abilities might experience dreams that have impoverished visual content – and might thus be more difficult to remember and misinterpreted as black and white dreams. Barber (1969) found that when people were given

several dream reports to read, the dream reports of high dream recallers were more easily remembered than the narratives of poor dream recallers.

Regardless of the actual mechanism of this relationship, visual imagery is a potential factor in the recall of greyscale dreams: good visual imagery might result in many coloured and vivid dreams and poor visual imagery might entail visually impoverished dreams which might be misinterpreted as greyscale by the dreamer.

4.3.1 Visual imagery styles

The differential importance of general visual imagery and spatial imagery has been touched upon in the previous paragraph. Visual and spatial imagery can be related to the two visual processing streams that were proposed by Mishkin, Ungerleider and Macko (1983): the 'what' pathway that corresponds to the detailed perception and imagery mechanism that renders shapes and colours, and the 'where' pathway that processes the spatial information about the environment or the spatial components of imagery. Neurological studies have found support for the distinction of object and spatial imagery: Knauff, Kassubek, Mulack and Greenlee (2000) found that the primary visual cortex areas (mentioned above) activate in visual imagery mostly when the imagery tasks requires detailed colour and shape visualisations, while spatial imagery tasks activate parietal areas that are involved in spatial processing. Moreover, there is evidence that both of the streams are mostly functionally separate (Milner and Goodale, 1995) and that lesions in their respective pathways can induce selective deficits in spatial cognition (optic ataxia and hemispatial neglect) or object recognition (visual agnosia).

What is relevant for the issue of dream colour is that there are marked individual differences in how good people are at employing these modes of processing. Kozhevnikov,

Kosslyn and Shephard (2005) found that apart from the traditional visualiser – verbaliser distinction, people who are good at visual imagery tasks can be further subdivided into two groups – those who use imagery to construct colourful and pictorial representations of objects (Object imagers) and those who prefer to schematically represent the spatial relations between objects (Spatial imagers). This distinction looks very interesting from the perspective of a researcher trying to explain the phenomenon of greyscale dreaming. The type of visual imagery used by spatial imagers fits neatly into the definition of 'colourless visual imagery' and it is quite conceivable that people who excel at spatial imagery (and are poor object imagers) could report having greyscale dreams. Conversely, the visualisation skills of object imagers should result in vivid and colourful dreams. If the visual imagery preferences can be separated from the effects of visual memory, it might be possible to uncover evidence for the reality of greyscale dreaming – or even achromatic dreaming.

4.4 Age

The final section of this chapter will review the cognitive and biological features of ageing that could be relevant to the issue of colourless dreaming. Existing studies have identified age differences in the frequency of coloured and greyscale dreaming (Stepansky et al, 1998), and it is thus important to understand whether these differences reflect the cohort effects – the college students who could have participated in the late 1950's experiments are 60-70 years old now – or whether they are a sign of normal, age-related changes. The main areas of age related cognitive changes discussed here are the changes in sleep structure, dream recall frequency and detail as well as age differences in visual memory and imagery.

4.4.1 Dream recall frequency and dream content.

There is no evidence to suggest that dream recall frequency is affected by the ageing processes. Longitudinal studies suggest that dream recall rapidly decreases between the ages of 20 and 38 (Giambra, Jung and Grodsky, 1996; Herman and Shows, 1983-4) and evens out in later life. This drop is apparently not connected to aging mechanisms, but rather to the interference from life concerns which increases as people enter adult life. It is crucial to point out, however, that there are marked differences between the results of longitudal and cross-sectional studies (Funkhouser, Hirsbrunner, Cornu and Bahro, 1999), and the results of old and new studies on ageing and dream recall (Schredl, Schroder and Low, 1996). It is suggested that the current generation of older people is more interested in dreaming and has a higher rate of dream recall than the previous generations did. There is also a difference in the results of home and sleep laboratory studies, with the latter resulting in lower dream recall rates than the former – a disparity that can be attributed to the fact that older people find it more difficult to fall asleep in the lab.

One aspect of dream recall that does change with age is dream length – Schredl (1991) in a dream diary study found that dream length is negatively correlated with age, a finding supported in his subsequent study (Schredl et al, 1996). This finding is important for dream content studies, and can be explained by the fact that with age REM periods tend to be more numerous and shorter – and REM sleep length has been linked to the length of the resulting dream report (Dement and Kleitman, 1957). Other studies, however, have not always found such a difference – a sleep lab study by Fein et al. (1985) did not find any dream length differences. Because dream length is an indirect measure of the details that are remembered from the dream, the shorter report length might mean that older people recall fewer details

from their dreams. In the light of the previous discussions, poorer recall of dream details might lead to an overestimation of greyscale dreaming.

4.4.2 Dream visual content

Dream content, exemplified by the emotional tone, type of actions and characters in the dream undergoes a lot of changes with age (Funkhouser et al, 1999) – but for the present investigation the most important age difference lies in the visual content of dreams. Fein et al. (1985) found that when sleep lab dream reports from young and old (age between 69-75 years) adult women were compared, there was a significant difference in the counts of words referring to the dream visual content – the numbers of nouns signifying visible objects, action words, visual details and spatial details were reduced in the older women's dream reports. Lower amount of visual details could be a result of lower REM sleep quality, or shorter REM period, however that is unlikely in this particular study, as there was no significant age difference in dream report length. A subsequent study found that older people have reduced REM sleep density (Darchia, Campbell and Feinberg, 2003), which might contribute to the relative paucity of visual details. In previous research higher REM sleep density (increased rate of eye movements) was linked to better dream recall and more vivid and visual descriptions of the concomitant dream (Baekeland and Lasky, 1968; Goodenough, Lewis, Shapiro, Jaret and Sleser, 1965). On the other hand, the results of this single study are in disagreement with the body of research concerning visual imagery discussed below. Therefore, unless dream visual image generation follows a different path to that of waking visual image, it seems that the paucity of visual details in the dreams of older people is more plausibly attributed to the difficulties with visual memory.

4.4.3 Visual memory

Very few studies have been done on the influence of ageing on visual memory, and the available evidence gained from these is somewhat inconsistent. Some researchers have posited that visual memory does not change with age – for example Sekuler et al. (2005) have found that older adults were just as good as young adults on a recognition task using sinusoidal gratings as stimuli. However, studies that used more realistic stimuli (such as faces or drawings) did find age related declines in visual memory (Park et al. 2002). Dror and Kosslyn (1994) have also found that older adults have problems with accessing a previously stored visual image – including higher response times as well as a higher error rate in recall. This point is of particular importance for the issue of age differences in greyscale dreaming, as it can influence the visual detail recalled from a dream and thus impair the ability to correctly remember and judge the colour mode of the dreams. On the other hand, a study carried out by Shaw (2007) has established that while there is an age decline in visual memory, it does not set in until late 60's and middle-aged adults have in fact better visual memory than both young and older adults – who share similar levels of visual memory abilities. One thing to bear in mind is that in most studies, visual memory was tested by recognition tasks (Shaw, 2007), which is a method that might not reflect the mechanisms associated with the recall of dream visual elements. Therefore, any conclusions proposed by those studies might not necessarily apply to dreaming, and the impact of ageing on the recall of visual elements from the dream might be larger or smaller than anticipated. However, overall, there are currently no strong reasons to suspect that age changes in visual memory will be a factor in greyscale dreaming.

4.4.4 Visual imagery

Since visual imagery has been pointed out as a possible source of greyscale dreaming, it is important to understand whether those abilities change with age. The few studies that were carried out on older populations have established that visual imagery does change in the ageing process, although not in ways that could have an impact on dream colour. Dror and Kosslyn (1994) found that while image generation and scanning are unimpaired with age, there is a decline in the abilities to rotate images. The fact that image generation and vividness (Pierce and Storandt, 1987) are not affected by ageing is important because it provides grounds for claiming that older people experience dreams as visually and vividly as the rest of the population and any differences in the rate of coloured dreaming stem from other factors – such as visual memory or black and white media influence.

4.5 Summary

This chapter identified and discussed the three main factors that might be responsible for the individual differences in the colour of dreaming, and one factor – age – that could be a reason behind some of the generational differences that have been discovered.

Neurological damage is not a viable explanation for widespread reports of greyscale dreaming (especially considering their sudden cessation), but the analysis of the brain basis of colour vision and imagery has demonstrated that the experience of colour is relatively fragile. There is a possibility that the visual regions of the brain are not activated enough during sleep, either in some particular situations (NREM sleep, for example) or in some people, resulting the experience of greyscale dreams. Even though this mechanism does not explain the high

frequency of greyscale dream reports in the early 20th century, it provides a background for the individual cases of greyscale dreaming. While this option cannot be addressed through research in this thesis, it is nonetheless important to consider. The second main factor, memory for visual aspects of the dream, explains why people would report greyscale dreaming without actually experiencing it. Dreams are difficult to remember, and the details of the dream visual experience which have to be recalled to make an accurate assessment of dream colour are even more so. Therefore, people who have lower visual memory abilities might report more greyscale dreaming despite having just as many coloured dreams as the rest of the population.

The final cognitive factor that was discussed was visual imagery, with imagery styles being a particularly interesting possibility. As visual memory focuses on the reasons for recalling greyscale dreams (or rather, not recalling enough colour cues from dreams), the visual imagery factors would work to actually produce greyscale dreaming. The existence of two distinct visual imagery styles, one focused on creating detailed and colourful pictorial representations and the other creating schematic and three dimensional sketches provides a novel and promising theoretical basis for the explanation of greyscale dreaming experience. If individual visual imagery styles can be shown to correspond with the type of dreams reported independently of any visual memory correlates, the ‘dream shift’ hypothesis will receive strong support, since one of the main arguments against it is the lack of solid theoretical explanations of colourless visual imagery and dreaming (Schwitzgebel, 2006).

Finally, the discussion of ageing changes in each of the main cognitive factors has revealed that while there is a definite influence of age on visual memory and imagery, it would be difficult to argue that ageing has the potential to be a big factor in the reporting of greyscale dreaming. Most of the ageing effects appear very late in life and have either been

not consistently found, or are very small. Visual memory, which has been often pointed out as a key factor in the reporting of greyscale dreams (Schredl, 2008) only declines meaningfully quite late in life, while the changes in visual dream detail are inconsistent with the changes in visual imagery and thus are at best an ambiguous argument for the role of ageing in dream colour.

Figure 6 below shows the factors that were reviewed in this chapter and illustrates how they are interlinked.

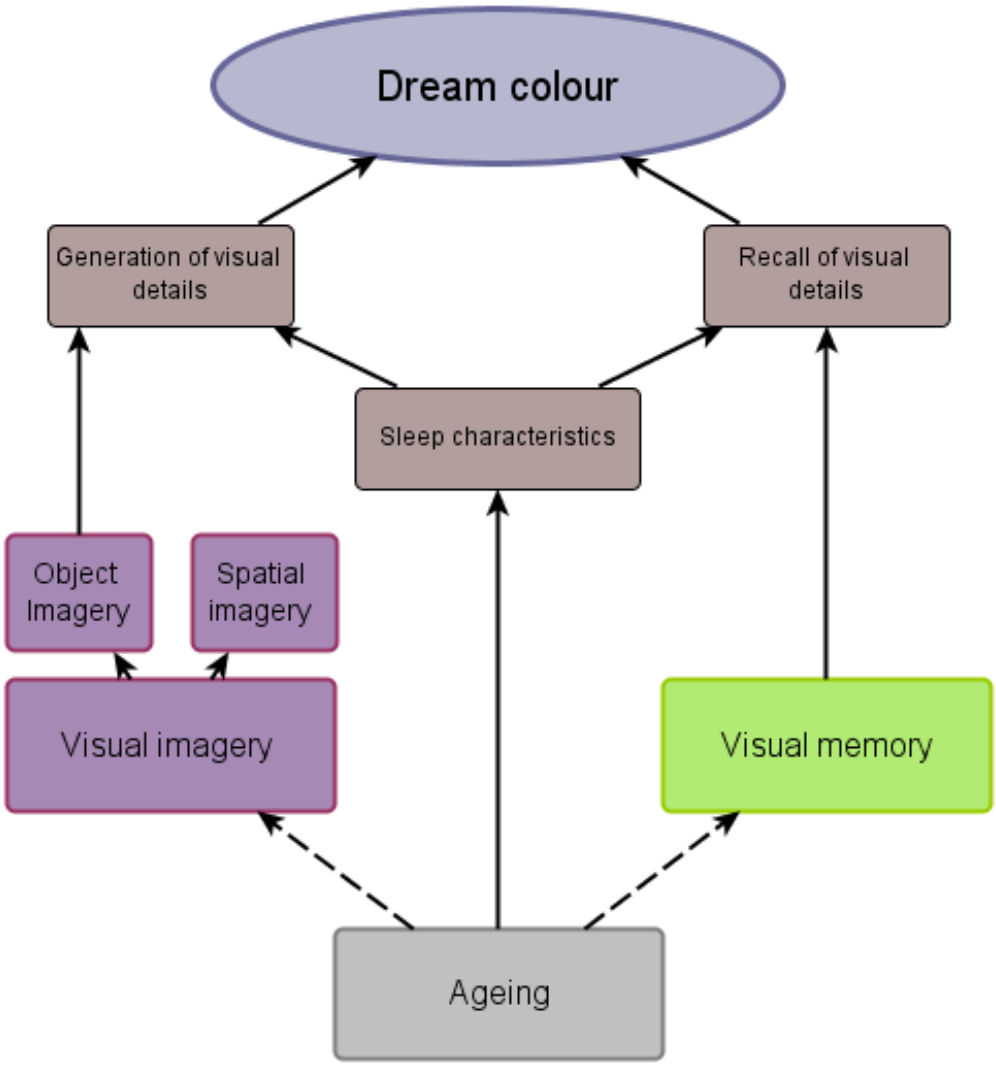


Figure 6: The impact of imagery and memory on dream colour.

CHAPTER 5: METHODOLOGY

Because each study in this thesis was planned and carried out independently, with many innovations and ideas arising as a result of the previous studies, the methodological details specific to particular studies will be discussed in their respective methods sections in the studies chapter. This chapter will focus on the general methodological issues with dream research, with particular attention paid to the methods of gathering dream reports and the issues involved with coding dream content. I will first present the research problems relating to the ontological status of dreaming, define what a dream and dream report is and present the issues involved in estimating the reliability and validity of dream reports. Then I will look at the different ways of collecting of dream reports and dream judgements and place them in the context of the studies I carried out.

5.1 Defining dreams

5.1.1 Are dreams experiences?

One of the first and main issues that dreaming research had to tackle was scepticism regarding the status of dreams as experiences. The first person to bring up these doubts was Maury (as cited in Freud, 1991) who, basing on one famous ‘guillotine’ dream concluded that even the longest dreams happen in the brief seconds before full awakening. The authenticity of Maury’s dream report was later questioned, as he only started talking about it years after the purported dream had taken place, but in the meantime the idea that dreams are not actually experiences found more supporters. Malcolm (1959) argued that people simply have a tendency to confabulate stories when they wake up, therefore dreams have no external

existence outside of these stories, and there is no meaningful way in which such a ‘dream report’ can be evaluated as a reliable reflection of the dreamer’s sleep experiences. Malcolm’s clams were based on a very peculiar understanding of consciousness, in which the very idea of a person forming a judgement of ’I am asleep’ was meaningless because being unable to form judgements was a part of the definition of being asleep. This circular reasoning could thus be easily dismissed by changing the definition of ‘asleep’.

Dennett (1976) provided a more interesting challenge to the validity of dream reports: the dream narratives are indeed composed during sleep, but this process does not involve any conscious involvement or experience from the sleeper. Upon awakening, one of the many prepared narratives is inserted into the memory and the contents of this ‘cassette’ are falsely taken by the dreamer as a memory of her experiences before awakening. While this challenge to the reality of dreaming still leaves researchers with something to investigate – namely the dream reports, it removes a key feature of dream research, namely the ability to investigate dreaming as a state of consciousness, rather than a memory fabrication.

Fortunately for dream research, there is now a lot of evidence against this theory. Firstly, research done of the relationship between REM sleep talking and the reported content of dreams found that there is good agreement between what people sleep talk and what they later report they said within their dream (Arkin, 1991). Secondly, it was discovered that people with REM sleep-behaviour disorder (who suffer from a lack of muscle atonia typically seen in REM) often show vigorous physical activity in REM sleep. When they are awoken, they typically have no recollection of having actually moved physically, but they relate dreams in which they were performing the same actions (Schenk, 1993). Finally, research on lucid dreamers (LaBerge, 1985) has provided conclusive evidence for dreams as events that occupy a time period during sleep: experienced lucid dreamers are able to signal from within

the dream using pre-arranged eye movement signals, communicating the presence of certain dream elements, or attempting a cognitive task. The numerous evidence for the correspondence between physiological measures and dream content is currently considered sufficient to overcome the 'dreams are not experiences' challenge, thus allowing dream research to address topics beyond simple memory and dream construction.

5.1.2 Definitions of dreams and dream reports

One of the most popular definitions of dreaming was coined by Hall (1953), who said that 'A dream is a succession of images, predominantly visual in quality, which are experienced during sleep.' (p.3). However, as it has been pointed out, these visual images are only the way in which a dream is recollected when we are awake. 'Dreaming itself is a primary state of existence in a world – an imagined world, but a world nonetheless' (Foucault, 1984-5). A more inclusive definition states that a dream is a 'vivid, sensorimotor hallucinatory experience that follows a narrative structure' (Nir and Tononi, 2010). Even in this case, however, the imagery introduce a bias in reporting towards a definition of dreams which is more suited to the intense REM dreams as opposed to the more mundane and verbal NREM dreams. Therefore, a modally neutral definition of 'anything that was going on in a person's mind during sleep' is typically used when people are queried for their dreams in a sleep lab or dream journal situations in order to include all forms of mental activity during sleep. It needs to be mentioned that this definition is well structured for obtaining dream reports from REM awakenings, but it might not be as appropriate for gathering home dream reports as people are often uncertain about their sleep status.

When the dream is successfully remembered it can be then written down or otherwise related to form a dream report: 'a set of judgements, albeit unsystematic judgements, about

the subject's private experience prior to awakening' (Antrobus, Fein, Jordan, Ellman and Arkin, 1991, p.84).

5.2 Obtaining dream reports

Since the main way of making the private experience of dreaming available for others is through creating a dream narrative, the choice of when and how the account of the dream events is made is important for the validity and reliability of the research findings based on dream content. The experience of dreaming is separated from the dream report by 2 major steps – memory and verbalisation – there are numerous factors at work that introduce interference and bias into the process, some of which were examined as possible factors behind greyscale dreaming in chapter 3. Figure 7 on page 56 illustrates the road between dream experience and dream report, along with the various external and internal factors that have the potential to impact the quality of reported dreams. In this section, I will discuss the available methods of obtaining dream reports, assess the strengths and weaknesses of each and evaluate how comparable their results are.

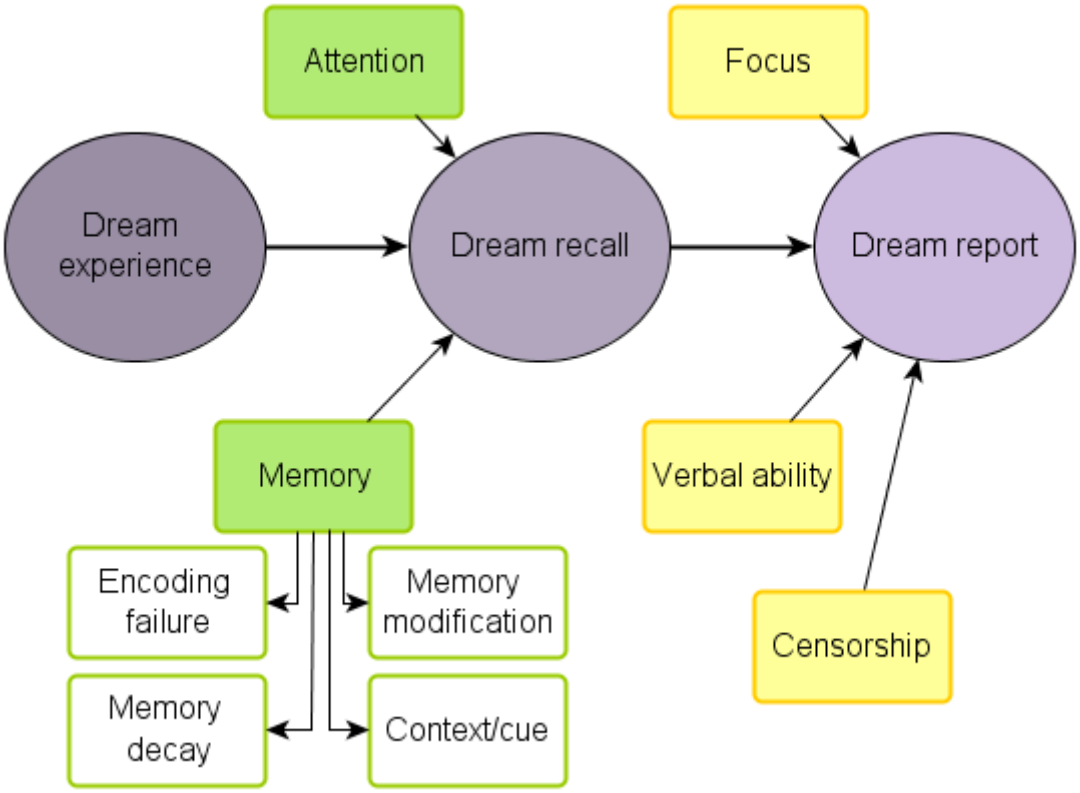


Figure 7: The road from dream experience to dream recall with some of the intervening factors.

5.2.1 REM awakening reports

The most immediate method of obtaining a dream report is through an awakening the person during REM sleep and asking them about the contents of their consciousness just before the awakening. The research that has validated dreams as actual experiences with a time span has also provided evidence that the sleep lab dream reports can be taken as reliable reports of sleep experience. Therefore, in the current literature that deals with dream report reliability, sleep lab dreams are treated as a baseline to which the other methods are compared (Domhoff, 2003). The main advantage of dream reports obtained through REM awakenings is the immediacy of the recall. The dreamer is woken up as the dream is being experienced and

is instantly prompted to recount the dream content while she is still lying in bed in a dark room. This minimises the impact of memory decay, interference and distractions, and allows for the recall of a dream from almost each REM phase. Moreover, the time between the start of the dream (defined as the beginning of the REM period) and the awakening can be controlled, and each test night yields 3-5 dream reports. The drawbacks, on the other hand are twofold. Firstly, the thoroughness of this method comes at a high price – the equipment, the sleep laboratory and the technicians necessary make this type of research often prohibitively expensive. The consequence is that often studies using this method use small sample sizes, compensating the fewer participants with a higher number of dreams recalled, which might impact the validity and generalisability of the findings if the individual differences in how people dream are stronger than researchers anticipate. Secondly, the design of waking people up only from REM sleep maximises the number of dream reports obtained during the testing nights, at the same time omitting any non-REM dreams that might appear in home dream recall. Thus, the dream sample gathered through REM awakenings is even further biased, since NREM dreams have different properties from the REM ones (Nielsen, 2000).

5.2.2 Dream journals and diaries

Home dream journal recording is a method of dream collection that is considered to be closest to the sleep laboratory, but without the accompanying financial costs and need for infrastructure. When the similarities between sleep laboratory and home recorded dreams were investigated, it was found that majority of home dreams were most similar to the late REM periods laboratory dreams (Domhoff, 2003). This was later found to be an effect of recency, rather than any particular properties of morning dreams, as the early and late REM dreams are very similar in terms of content and length. Interestingly, dream salience had a

smaller impact than dream length – when sleep lab participants were asked to recall their dreams in the morning (after having already described them at night) the longest and most recent dreams had better rates of recall than the simply salient ones. Thus, there is currently an agreement that home collected dreams are as reliable as those gathered in the sleep lab.

The dream journal method has two variants: one in which volunteers are asked to start keeping a short term dream journal for the purposes of a study, and one in which people's independently kept longitudinal dream records are used for analysis. The main difference between the two methods is in the amount of distortion, confabulation and censorship that can occur. The personal dream journals that were written for private use are most likely free of such distortions or censorship and there is no reason for the authors to confabulate dream reports. The value of 'on-demand' diaries, on the other hand, can greatly suffer from the fact that the dreamer is aware of external scrutiny of their dream life. Firstly, mandatory participation in dream diary studies (such as is sometimes seen in studies carried out on psychology students) can lead the participants to confabulate dream reports (Domhoff 2003, p.51), and increases the probability of obtaining hasty and incomplete dream reports. Secondly, dreamers can provide censored or distorted dream reports since they know these will be read and analysed by researchers. The second problem is not insurmountable, as providing anonymity throughout the study lessens the pressure to present a positive self-image. Moreover, there is some evidence that people treat dreams as experiences they are not personally responsible for, and therefore feel reasonably free to report their dreams faithfully (Foulkes, 1979; Hall and Van de Castle, 1966) despite the awareness of scrutiny. The final problem is related to experimental influence – short term, research driven dream reports can be subtly influenced by the perceived demands of the study. Despite all these issues, short-term dream diaries are still one of the most effective ways of obtaining dream report series, as

the alternative personal dream journals are kept only by a very small, self-selected percentage of the population. While they can be a fascinating source of longitudinal dream data, the generalisability of these findings to a population less interested in dreams requires caution. Moreover, it is difficult to control whether the dreams in a personal diary are indeed a daily record of the dream life, or are selected by the dreamer for personal reasons.

A separate and somewhat new category of dream journals are 'pseudo-personal journals' that are kept regardless of any research, but are at the same time available to other people, usually through the internet. This type of dream records can be modified by the dreamers to present a more favourable self-image through omissions and distortions, and has been strongly criticised by Domhoff (2003) as a source of data for research. However, I want to argue that this criticism should mostly apply to dream journals that are published under the dreamer's own name or on a site that encourages attempts at self-presentation through extensive networking. Dream reports posted anonymously (under a pseudonym), on large sites which do not provide the facilities for such social activities as extended commenting and which are devoted only to keeping own dream records, should be as reliable as pen and paper personal dream journals. A lot of people use the online dream banks not to impress their readers, but simply because typing dreams is faster than writing them down by hand, and keeping an online journal safeguards the records from personal hardware issues. No research has been done on the comparability of the dream records kept in such dream sites (such as dreamjournal.net or sawlogs.net) and dream reports obtained by traditional means, which is unfortunate since the online dream journals present the researcher with a wealth of easily accessible longitudinal data, and often a way to contact the dreamers to obtain further data, such as cognitive measures or lifestyle information.

5.3.3 Most Recent Dream Method

The simplest way of obtaining dream reports is through the Most Recent Dream Method (Hartmann, Elkin and Garg, 1991). This method provides a very efficient and standardised way of collecting numerous dream reports in a short period of time, even in a group setting. The Most Recent Dream Form instructions simply ask people to write down their latest dream; they can be modified to suit the study needs and additional questions about dream recency or other demographic variables can be easily added in. Most importantly, the dreams obtained by this method are rarely censored or modified, since the dream reports are collected anonymously and in a single interaction. There is a possibility though that they are not entirely representative, since people might record their recent most interesting or important dream, as opposed to just the latest one. This issue is particularly important is conclusions about individual differences in dreaming have to be extracted from a single dream reports, since the differences in which dreams people choose to report (latest vs. most easily recalled) might overshadow any differences related to the cognitive or personality correlates of dream features. Nonetheless, Domhoff (1996) established that dream reports obtained using the most recent dream method are very similar in terms of dream properties to the dreams obtained in a sleep laboratory. While there is no research that compares MRD reports to normal home dream recall, this method is still the most efficient and simple way of gathering dream data.

5.2.4 Questionnaires

The final way of gathering data about dreams is through dream related questionnaires. This approach foregoes the collection of dream narratives and instead allows the dreamers to report relevant features of their dream life. This is a very useful approach when the content

details of dreams are not as important as the general dreaming characteristics, when the dream phenomenon investigated is quite rare and at the same time a long term dream journal is not feasible. Similarly to the Most Recent Dream approach, this method is fast, can be completely anonymous and is easy to administer in a group setting. The main drawback is the reliance on people's own self assessment of their dream life, which has been discussed more extensively in chapter 3.

5.3 Working assumptions for thesis research

Each research project starts from a wide array of possible approaches to the research question and then has to focus on the specific research methods and variable operationalisations. This section explains the definitions of dreaming that were employed in the studies for this thesis and presents the methodological and conceptual decisions that were made.

5.3.1 General methodology

There is usually little space for a true experimental design in field of dream research, and this was indeed the case for the present studies. Therefore, the quasi-experimental and correlational approaches were implemented, so that tests were carried out on populations that were already differing in the key variables (such as dream colour) in order to discover the factors behind those differences. While correlational studies are often simpler to undertake than true experiments, they preclude the possibility of making any judgements about the causality of the discovered effects. Therefore, the entirety of the results and conclusions drawn from the studies in this thesis should be treated as tentative evidence rather than conclusive proof.

5.3.2 Dream definition used

The main subject of this research series was the colour reported in dreams and the visual and spatial details of dreaming. While dreaming was never explicitly defined to the participants (in dream diary instructions or Most Recent Dream form), the focus was placed on the action of the dream and its visual contents. Therefore, the instructions regarding which aspects of their sleep mentation they should pay particular attention to when writing their dream report highlighted the visual aspects of dreaming. The main advantage of this approach is in saving the participants time and effort. When people are asked to describe a dream they had in full detail (especially if the dream was long), they will rarely produce a full report of all the dream features, because of time constraints and low motivation. This problem is especially pronounced when short term dream diaries are used, since the people who participate in these rarely keep their own dream records and might not be as motivated and interested in dreaming as those who keep spontaneous dream journals. Focusing on a few select aspects of the dream shortens the recording process and allows the participants to write down the details that are important for the analysis – some of which could have been omitted to make space for descriptions of feelings after awakening or waking-life influences on the dream. The main disadvantage is the fact that through changing the focus of dream report, the reports become hard to compare to dream reports obtained with a different instruction, and there is a possibility that changing the focus of the dream report will not impact all participants in the same way. There is also a risk of having the participants confabulate the visual elements of the dream, when there were little to begin with. This issue can be partially dealt with by making sure that the participants know that every dream report, regardless of length and detail is important – which has been done in the current study.

5.4 Methods of obtaining dream reports and dream evaluations

Since the sleep laboratory method was unavailable for this research, other ways of obtaining dream reports had to be used. The studies reported in this thesis employed a variety of these methods: a rating style dream diary that combines the features of a morning dream journal and a questinnaire (Study 1), full dream diary (Study 8), personal online dream journals (Study 6) and most recent dream method (Studies 5 and 7). The remaining studies did not gather dream reports, but only used a questionnaire to gather the relevant information about dreaming, namely the colour experienced in dreaming. This type of questionnaire was also used in the dream diary studies together with the diary.

5.4.1 Dream diaries

The dream diaries used in this study were designed to minimise rates of false recall and distortions. Firstly, anonymity was ensured by the following steps: the participants were always given a dream diary after the laboratory part of the study was complete. The diary was only labelled with a number, which was also placed on the other materials from that participant and any data used to contact that participant and to identify the volunteers by the assigned numbers was removed. The participants were provided with an easy and anonymous way of returning the diaries, either in pre-paid envelopes or through a drop box placed in the psychology department. Therefore, the completed diaries were fully anonymous and the care was taken to make the participants aware of that. Secondly, the potential fabricated dream reports were addressed by underlining the importance of non-recall in the study. The participants were all informed that not providing any dream reports is as valid as writing down a dream each night, and that dream recall frequency was a significant part of the study

data. When rewards for completing the study were provided (such as course credit or monetary incentives) the validity of returning an empty dream diary was stressed even more, to avoid the participants feeling obliged to provide some dream reports for the study. While this approach could result in participants returning less dream reports by demotivating them, it should ensure that the participants most likely to fabricate dream reports to get course credits will prefer to hand in empty diaries. Finally, all of the studies were voluntary and there was no course obligation to participate in these particular experiments since there was a wide variety of studies available for course credit. While some of the students did receive course credits for their participation, this was not tied to providing actual dream reports, as was explained above.

The dream diary used in study 1 was different in that it did not require the participants to write down the contents of their dreams, but only to rate their recall of the key elements of a dream and then provide an assessment of the colours seen in the dream. This design was used because the initial studies did not aim to investigate dream content, and this approach was deemed as the most efficient way to gather morning dream 'reports' without burdening the participants with writing down full descriptions. This was especially relevant because one of the groups investigated were seniors. The defining element of this method is that it places the onus of coding of dream memories into a quantifiable scale from the researcher onto the participant. In a typical dream diary the quality of recall of elements such as dream characters, places, events and visual aspects would have to be extracted from the dream report through the means of a coding scale. The individual differences in writing ability and tendency to include details that are tangent to the dream narrative can, however, obscure the actual content differences. Allowing the dreamers to self-rate their dream memories removes this problem, as the dreamers can quickly review their memories of the dream and assess how well they can

recall each element. They key issue is setting up a point of reference for the assessment, such as comparing the dream memories to the memories of the previous day's events or a recently watched movie. Such a reference point will set up the dream recall judgements as relative to the dreamer's general 'incidental' memory ability, which has two consequences. The beneficial one is that the resulting ratings reflect the dream recall adjusted to the individual memory abilities, which in turn highlights if the person has a disproportionate problems recalling dream content when compared to waking life experiences. The flip side is that the individual differences in introspective abilities and the assessment of own ability can obscure the actual memory differences, and the participants must make sure they take their time to make accurate judgements of their memory contents. However, it seems plausible that the participants will be more eager to spend a minute or two rating their memories thoroughly rather than spend 10-15 minutes recording their dream with minute details. This method also encourages the participants to record poorly-recalled dreams, from which maybe one or two images and a leading event are recalled. Those are the dreams which they could be withholding in a normal dream diary format and which would be impossible to code in a normal dream diary format.

5.4.2 Online personal journals

The online personal dream journals were used for one study in order to test whether the results gathered using Last Recalled Dream paradigm are comparable to privately kept, morning recall dreams. The key issue with using online dream diaries (as suggested by Domhoff, 2003) is the reliability of dream narratives posted on publicly available sites, in a format that can be changed at any point of time. To circumvent these issues, restrictions regarding the type of sites and journals were undertaken. The two websites that were chosen

to gather dream reports from were DreamJournal (www.dreamjournal.net) and SawLogs (www.sawlogs.org). Both of these sites provide anonymous dream posting services, along with simple tools for dream analysis or theme detection. The large scale and specialisation of both sites combined with the anonymity of users serve the function of limiting social feedback the users might receive from other members, possibly decreasing the temptation to censor or fabricate the dreams to comply with social expectations. The main criteria used when searching for dreamers to contact were the number of dreams posted and the timing of the last dreams posted – since only 10 dreams would be used for analysis it was important that they were recent and recorded within a period of time shorter than 2 months. Additionally, since word count was used as an element of dream report selection (as only dreams longer than 50 words were coded), dream journals that consisted mostly of very short entries (10-30 words) were eliminated from the pool. This was done to avoid cherry-picking 10 unusually long dream reports from dreamers who typically posted very short dreams, since the longer ones might then not representative of the person's typical dreams.

5.4.3 Most Recent Dream

The most recent dream method, developed by Domhoff (1996), has been slightly modified for use in this research. The main strength of this approach is the ability to collect numerous dream reports in a quick and efficient manner usable in a group setting. To make sure that the participants were making the most out of the limited time they could commit to the dream report, the typical instructions for the Most Recent Dream form were modified to place less emphasis on the recording of the emotional aspects of the dream and the waking

life references, and instead prompted participants to focus on the content of the dream, with a specific attention to the visual elements of the dream. Narrowing down the range of dream experiences the participants have to write down should result in the dream reports being a better reflection of actual dream visual imagery and memory, as opposed to being determined by what elements of the dream the dreamers – and the cultural scripts – consider important (which are usually the meaning and waking life references). The only issue with this approach is that the different instructions render comparisons with the traditionally gathered MRD reports problematic – any differences between the datasets could be attributed to the instructions.

CHAPTER 6: EXPERIMENTS

The thesis consists of 7 studies that were carried out across 3 years of research. The main aim of all of the studies was to investigate the phenomenon of greyscale dreaming and to find out whether the factors identified in the second and third chapters are indeed related to how dream colour is reported. Because all of the studies carried out were exploratory, the research questions shifted from study to study as the understanding of what factors might impact the colour of dreams was informed by new literature and the results of previous studies. Figure 8 on page 69 displays the main factors each study addressed and the main aspects of the methodology of each of the studies.

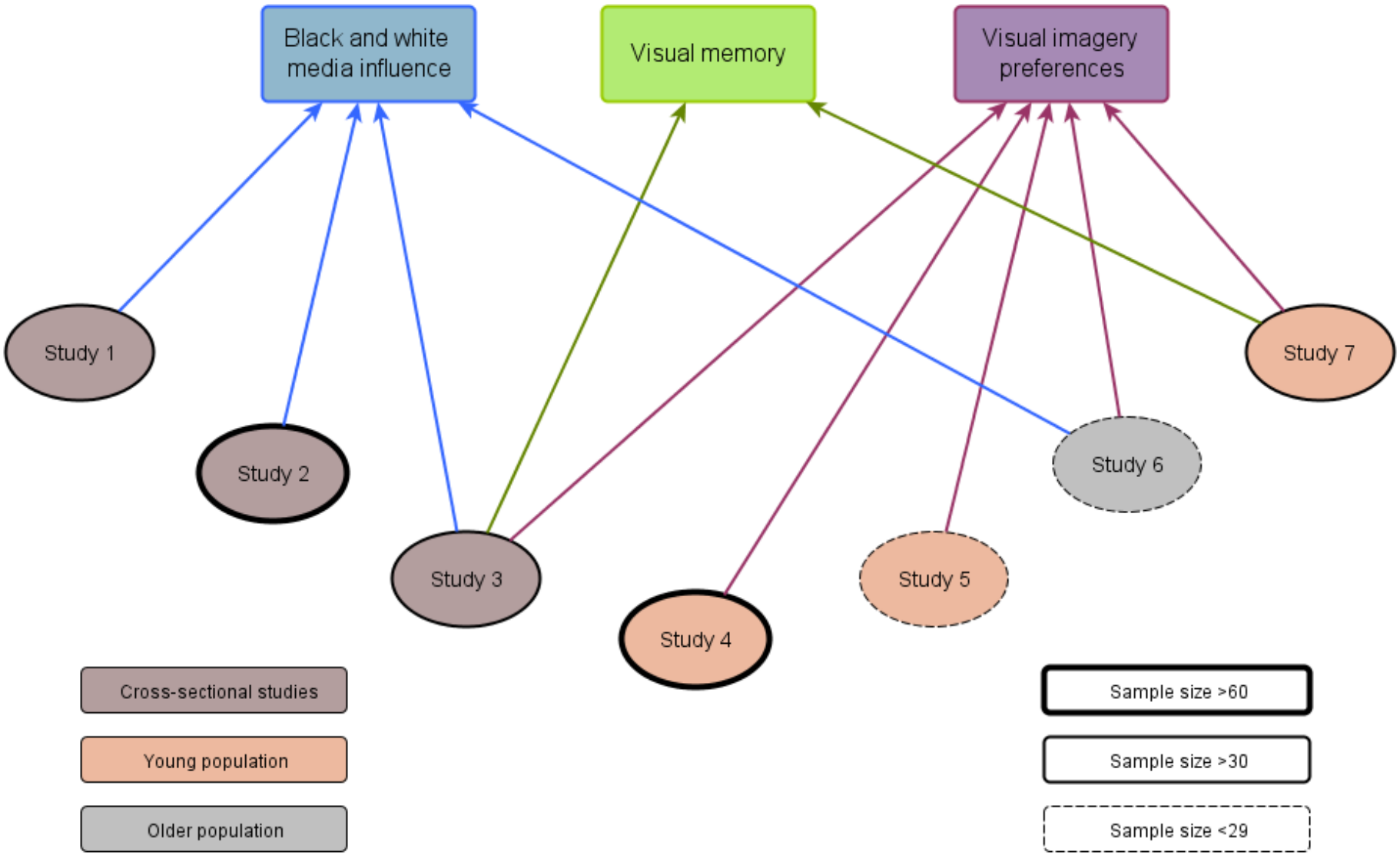


Figure 8: Overview of studies and their main features.

6.1 Experiment 1: Age differences in the colour of dreams

6.1.1 Objectives and hypotheses

The first study in this series set out to confirm the findings of Stepansky et al. (1998) regarding age differences in dream colour and to see if those generational differences can be attributed to the impact of black and white media. Age and media experience were identified as key factors in the creation of greyscale dream reports and were thus identified as the primary targets for investigation. This aim was pursued through examining two distinct age groups: people under 25 and people over 55 years of age. The primary hypothesis was that people in the older age group would report more black and white dreams than people in the younger group. The second hypothesis stated that the amount of greyscale dreams in the older group would be positively related to the amount of black and white media experience in childhood.

Because methodological differences have been identified as a potential factor, this study additionally attempted to address this issue by using both a questionnaire and a dream journal assessment of dream colour. The main hypothesis here was that there would be a difference in the type of dream colour as reported through the questionnaire and as assessed with the diary.

Memory for dream details was the final factor considered – one of the postulated differences between dreams labelled as colour and those labelled as greyscale is the quality of dream recall. Is is suggested that poorly recalled dreams might be labelled as greyscale by the dreamers due to insufficient visual details available. Thus, the goal here was to look at whether dreams that are labelled as black and white are more poorly recalled than colour dreams. The hypothesis proposed in the study stated that the dream diary dreams labelled as

greyscale would also be rated lower on recall quality than dreams labelled as coloured. Because of how age, memory for dreams and the postulated age differences in dream colour interact, a secondary hypothesis was introduced: the difference in recall quality between coloured and greyscale dreams will be present in the dreams of both age groups independently.

6.1.2 Method

6.1.2.1 Design

This study was a comparison of two age groups. The main variables investigated were the frequency of coloured and greyscale dreams, measured with a questionnaire and a dream diary. Dream recall quality was additionally measured in the dream diary. The independent factors were age, experience with colour and black and white media and attitude towards dreams. Attitude towards dreams was considered important because in previous studies it has been found to relate to reported dream recall frequency (Beaulieu-Prévost & Zadra, 2005) and quality (Wolcott & Strapp, 2002) and thus it was included as a factor.

6.1.2.2 Participants

Participants were recruited through the University of Dundee and community centre advertisements as well as by contacting volunteers in existing research databases. There were 30 males and 30 females in the study; half of each group were under 25 years of age (mean=21.45, SD=2.53) and half were over 55 years of age (mean=64.17, SD=8). The volunteers were paid £8 for their participation.

6.1.2.3 Measurements

Estimated dream colour type and media experience

The estimated type of dream colour and experience with media was measured with a questionnaire adapted form Middleton (1942) and later reused by Schwitzgebel (2006).The participants were asked to judge what their dream colour type is prior to starting the dream diary. They could choose one of the following options: *colour*, *black and white*, *both*, *neither* and *don't know*. Exposure to coloured and black and white media was estimated by asking about the age of first regular exposure to black and white media and coloured media (on a following scale: *0-3 years old*, *4-6*, *7-10*, *11-14*, *15 years and over*, *never*), the number of hours spent currently watching TV, and the percentage of programmes watched in black and white. An additional nominal variable which represented exposure to black and white media only was arrived at by subtracting the age category at which colour media were introduced from the age category for first access to black and white media and collapsing the result to either 0 (no exposure to black and white media prior to colour media) or 1 (exposure to black and white media prior to colour media). The questionnaire is available in Apendix 1.

Dream colour type

This variable was measured with a dream diary (available in Appendix 2). Every morning for 10 days the participants recorded the number of dreams they remembered and answered six yes-no questions about the colour qualities of each dream. The answers to these questions would later allow to classify the dream into one of three main categories: *colour*, *black and white*, *mixed* (containing both coloured and greyscale elements). Two additional categories were also included – one for dreams where the answer pattern was inconsistent with any interpretation (*unclear* type) and one for dreams where participants could not answer any of

the questions concerning colour in their dreams (*no recall* type). Two types of variables were extracted from this data: one which classified how each participant dreams in general – only colour, only black and white or both; and the other was a set of 6 variables which indicated how many dreams (in percent of the total dream count) a participant experienced in any of the above categories.

Dream recall quality

This set of variables was also measured with the dream diary. The participants rated how well the remembered the five dream constituents identified by Hall (1953), namely the characters, plot, setting, actions and visual scenes, for each dream they recalled. The five separate ratings were used because breaking up dream recall into smaller and better defined categories was thought to yield more accurate results. Additionally, more specific comparisons between memory for components could be made. The ratings were made on a one to five scale, where 1 meant no recall of that aspect, and 5 meant the person remembers it as well as any other waking event. General recall quality of a dream was obtained by averaging the ratings for the five components. Both individual dream ratings and ratings averaged across dreams were used in this study.

Attitude to dreams

Attitude to dreams was measured with a Likert scale developed for this study (Appendix 3). It consisted of eight items, each rated on a 1 (*completely disagree*) to 5 (*completely agree*) scale. There were five positively and three negatively worded items, three of these items reflected the behavioural aspect of attitude, three reflected the affective component and two concerned the cognitive component. Cronbach's alpha coefficient for the scale items was 0.80. Attitude

score was calculated by reverse scoring of the negative items, adding all the item scores and dividing by the number of items to achieve a score with a maximum of 5 and minimum of 1. A higher score reflects a more positive attitude towards dreams, while a lower score reflects a neutral or negative attitude.

6.1.2.4 Procedure

The session started with administering the media experience questionnaire. The participants were clearly instructed on the meaning of the 'coloured', 'greyscale' and 'mixed' dream options so that they could accurately fill out the questionnaire. After this, the experimenter presented the structure of the dream diary, explaining its features and making sure the participant understood the structure of the diary and were able to accurately report their dream experiences in this format. The participants were informed to fill the diary as soon as possible after waking up, and were told to keep it for ten consecutive days. The diaries were returned either in person or by post and the participants were paid £8 on returning the diary.

6.1.2.5 Analysis

Two types of analyses were conducted. The first one investigated individual differences in the frequency of coloured and greyscale dreaming and looked at possible relationships with age and media experience, through a set of independent t-tests. The second one employed analysis of variance and concentrated on the properties of individual dreams and investigated whether there are any differences in recall quality between different colour types of dreams. Both recall of visual scenes and general recall quality of the dream were used

in the analysis, since people are better at encoding and retrieving coloured visual stimuli (Spence, Wong, Rusan & Rastegar, 2006; Suzuki & Takahashi, 1997) but there is more to the recall of dreams than just the visual aspects.

6.1.3 Results

6.1.3.1 Media experience

Analysis of the dream recall and media experience questionnaire revealed the predicted age differences. Among the younger age group, all participants had frequent access to colour TV and films by the age of 6 (with 21 participants gaining such access before the age of 4). In contrast, none of the participants in the older group had access to coloured media before the age of 7 (with 17 participants gaining such access only after the age of 15). Furthermore, in the younger group 21 participants gained access to colour and black and white media at the approximately same age and 9 said they never had frequent access to black and white media. In the older group, however, 8 participants had such access by the age of 6, and further 19 by the age of 14. Most importantly, in the older sample there was a subgroup of 22 people who had had gained access to black and white media before they experienced coloured ones. The rank difference between access to colour and black and white media was equal to one (in 13 cases), two (in 6 cases) and three (in 3 cases). Figure 9 on page 76 illustrates these age differences

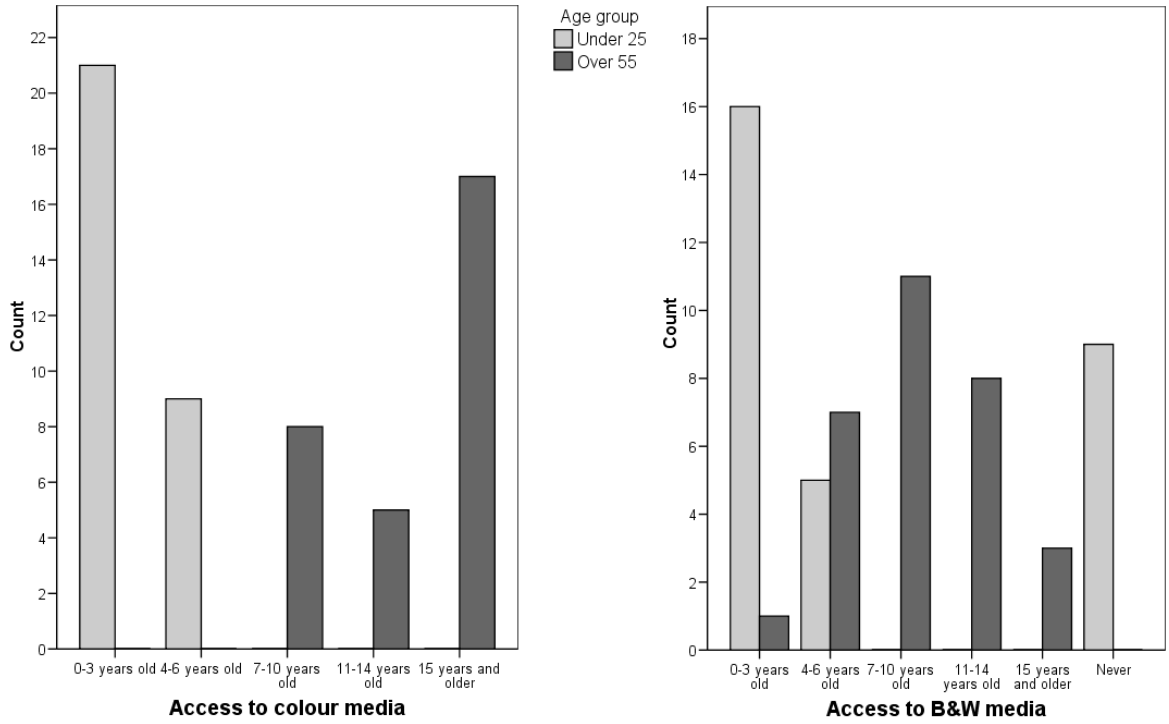


Figure 9: Comparison of media access for the two age groups

6.1.3.2 Attitude towards dreams

Attitude to dreams was included in this study because of its correlations with dream recall frequency and quality (Beaulieu-Prévost & Zadra, 2005; Wolcott & Strapp, 2002). There was a statistically significant age difference in attitude towards dreams ($t_{(58)}$=4.90, p<0.001).: the average score in the younger group was 3.94 (SD=0.59), while the older groups' score was 3.17 (SD=0.63). While people in the younger group were more favourably inclined towards dreams than people in the older group, both groups scored close to the positive end of the scale. In further analyses attitude to dreams was found to be correlated with variables that displayed age differences (such as dream recall quality). However, since there were no intra-group relationships (even marginally significant) between attitude and dream recall quality, and since age is a more robust explanation, it is safe to assume that these

correlations are an artefact of age differences. Therefore, attitude towards dreams was not used in subsequent analyses.

6.1.3.3 Frequency and quality of dreaming

There were no significant age differences in the average number of dreams experienced during the testing phase, with the younger and older groups reporting 11.20 (SD=4.57) and 11.23 (SD=6.70) dreams respectively. However, there were some marked and statistically significant ($t_{(58)}$=3.338, p=0.001) differences in the quality of dream recall: the general recall quality in the younger group was 3.06 (SD=0.58) as compared to 2.51 (SD=0.69) in the older group. This could mean that while the older group was just as good as the young group in remembering the occurrence of dreams, they were poorer in recalling the details of the dream. This was also the case with the specific measure of memory for visual aspects of the dream ($t_{(58)}$= 2.580, p=0.012), since the younger group rated their memories as better than the older group (3.12 as compared to 2.72). This result is important because it suggests that any age differences in recalled dream colour can be also attributable to memory issues.

6.1.3.4 Questionnaire dream colour versus dream colour as examined by dream diary

Analysing the questionnaire item concerning participants' beliefs on whether they dream in colour, black and white or otherwise yielded the age differences predicted by both sets of hypotheses. In the young group, majority of participants indicated that they dream in colour. In contrast, less than 1/3 of people in the older group indicated they only dream in colour. The dream diaries, however, have revealed a somewhat different pattern. In both

younger and older age groups the number of people reporting only coloured dreams has fallen and the number of participants reporting having both colour and greyscale dream has increased. There were no participants who reported having only black and white dreams, and only 1 (younger group) and 2 (older group) participants could not provide any information about the colour qualities of their dreams. Figure 10 presents the comparison between questionnaire and dream diary data in more detail.

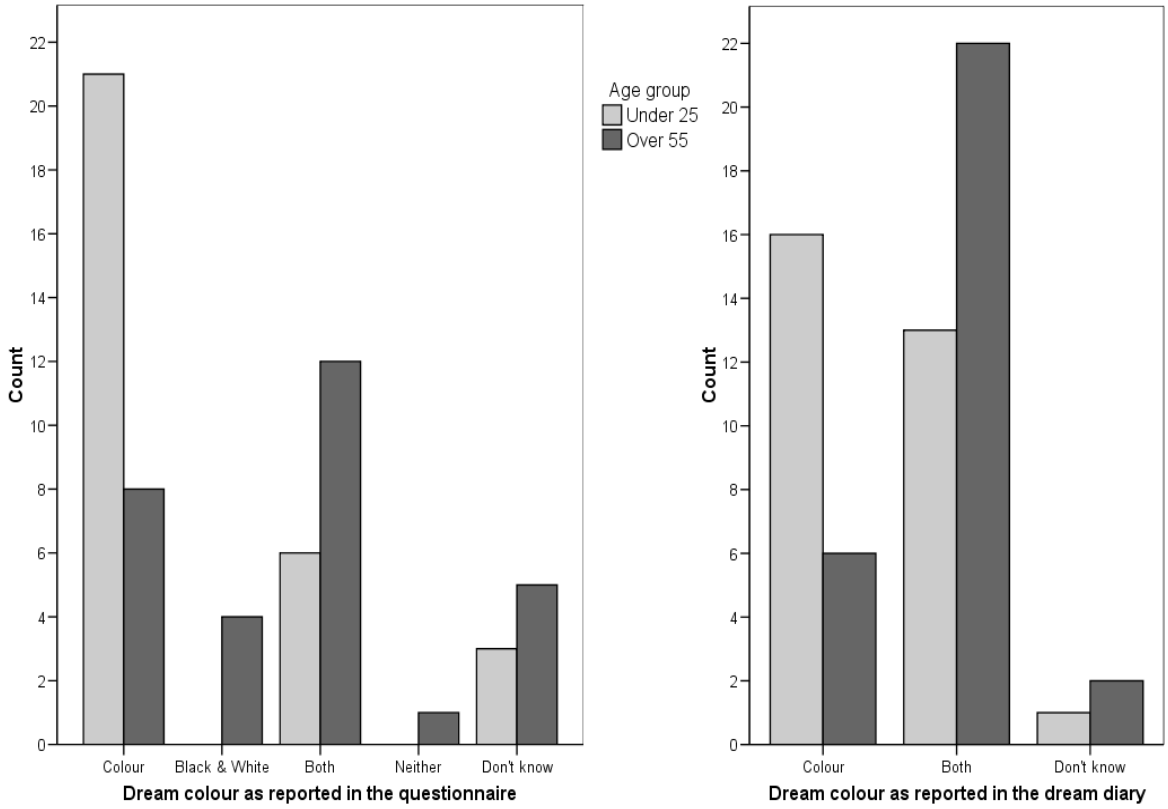


Figure 10: Dream colour types as reported in the questionnaire and dream diary

The Figure 10 and overview above summarise the overall 'dreaming styles', as estimated by the diary and questionnaire. It is also possible to look at the relationship between what individual participants reported in the questionnaire as opposed to the diary. A McNamara related groups test revealed that there were no significant differences in the

reporting of coloured dreams (N=50, p=0.29) and black and white dreams (N=50, p=0.45) between the questionnaire and the dream diary. Importantly, there were also no significant differences when individual age and media experience groups were examined. These results have bearing on both of the explanations considered in the introduction. The methodology explanation predicted that in the dream diary people over 55 should report black and white dreams less often than in the questionnaire, and that people under 25 years of age should not report virtually any black and white dreams.

These hypotheses were not confirmed by the data – in the young group 7 participants reported at least a single black and white dream (as compared to 6 who initially stated they have both colour and greyscale dreams); in the older group 17 participants had at least a single black and white dream (as compared to 16 in the questionnaire). Thus, the number of people reporting black and white dreaming has not changed when a different research method was employed.

An additional analysis of people's accuracy of dream type assessment was performed by comparing the dream type as claimed in the questionnaire with the dream type obtained from the 10 day sample of dreams in the diary. As no age related differences were found, the results are presented for the whole participant set. When looking at the reporting of colour dreaming, the questionnaire data were in accordance with the diary data for 75% of the participants, another 6.7% claimed to experience colour dreams but did not report any during the 10 days and 3.3% reported coloured dreams in the diary but had not done so in the questionnaire. The results are similar when black and white dreaming is examined: 70% of the participants reported black and white dreams in the diary and questionnaire, 8.3% claimed greyscale dreams in the questionnaire but did not report any in the diary, and 3.3% had only reported such dreams in the diary. It was impossible to determine the accuracy of the

remaining 15% and 20% due to ambiguity of the questionnaire data. Table 1 on page 80 presents this data.

Table 1: Questionnaire responses compared to dream diary data.

Percentage of people who:	Colour dreams	Black and white dreams
Correctly reported	75%	70%
Reported a false positive	6.7%	8.3%
Reported a false negative	3.3%	3.30%

It is important to note that it is likely that in this short study period the participants might not have had the chance to experience particular dream types, especially if they happen rarely. Moreover, the nominal nature of the dream colour data meant that the comparison between diary and questionnaire data could only be carried out on the most basic level. Nonetheless, the accuracy of the questionnaire data proved better than expected.

6.1.3.5 Age, exposure to media and dream colour

Two sets of independent t-tests were carried out, with age (under 25 and over 55) and black and white media exposure (had access before or after access to colour media) as the grouping factors. The dependent variables were the percentages of dreams dreamt in colour, black and white, mixed and unknown colours. Table 2 on page 81 shows the means and standard deviations, along with the results of the t-tests for the two age groups. During the period of the study people over 55 had experienced significantly less coloured dreams than people under 25, but they had significantly more mixed and greyscale dreams.

Table 2: Age differences in dream colour

	Age				
	Under 25		Over 55		
	Mean	SD	mean	SD	*p*
Colour dreams	68.44	31.80	33.94	36.86	<.001
Greyscale dreams	4.41	9.01	22.17	27.13	.001
Mixed dreams	8.74	13.77	22.17	15.71	.04*
Dreams with unrecalled colour	15.14	23.68	17.66	25.04	.69

Table 3 on page 82 shows the descriptive statistics and results of the t-tests carried out with experience to black and white media as the independent variable. Again, there were significant differences in the percentage of coloured, greyscale and black and white dreams in the same direction as in the previous set of tests. It is worth noticing that the t values were higher and the associated p values were lower. Considering that the group with no access to black and white media prior to colour media consisted of both older and younger participants, it is possible to conclude that media experience is the main factor responsible for the inter-group differences in dream colour. However, the high standard deviations seen within the necessitate caution and a separate comparison between larger groups of people over 55 with and without such experience would be needed to verify such a conclusion.

When the possible relationship between the length of sole black and white media access and dream colour was investigated (for the subgroup who had had such access) it was found that the shorter the time the more mixed dreams the person reported (r=.432, p=0.044). No other correlations were significant.

Table 3: Media experience and dream colour types.

	Media experience				
	No B&W access (n=38)		B&W access (n=22)		
	Mean	SD	mean	SD	*p*
Colour dreams	67.01	33.12	23.87	30.91	<.001
Greyscale dreams	5.02	11.09	27.57	28.27	0.001
Mixed dreams	7.68	12.63	21.50	15.50	<.001
Dreams with unrecalled colour	16.30	26.12	16.58	21.04	0.97

6.1.3.6 Analysis of dream colour and dream recall quality

A pair of two way ANOVAs was carried out with access to black and white media and dream type (colour, mixed and greyscale) as independent variables and with individual dreams' visual recall and general recall quality as the dependent variables. Planned contrasts were carried out for the interaction discovered.

Dreams with the average recall rating lower than or equal to 1.5 (white dreams) were removed from the analysis, as any attributions of colour qualities would have been unreliable. 66 dreams (12%) were removed from the set, 15 from the younger age group and 51 from the older group, resulting in a final set of 475 dreams.

The group sizes, means and the standard deviations of visual recall quality and general recall quality for each of the group types are shown in Table 4 on page 83.

Table 4: Dream recall quality and media experience

Group:	Dream type:	Visual recall quality			General recall quality		
		N	Mean	SD	N	Mean	SD
No early black and white media experience	Colour	289	3.59	1.067	289	3.39	0.964
	Mix	30	3.53	1.224	30	3.41	1.123
	Black&White	12	2.42	0.793	12	2.42	0.872
	Total	331	3.54	1.093	331	3.36	0.991
Early black and white media experience	Colour	49	3.76	0.990	49	3.28	1.113
	Mix	47	3.15	1.161	47	3.12	1.120
	Black&White	48	3.13	1.024	48	3.08	0.960
	Total	144	3.35	1.092	144	3.16	1.063
Total	Colour	338	3.61	1.057	338	3.37	0.986
	Mix	77	3.30	1.193	77	3.23	1.123
	Black&White	60	2.98	1.017	60	2.95	0.973
	Total	475	3.48	1.095	475	3.29	1.016

6.1.3.7 Visual recall quality

The assumption of homogeneity of variance was satisfied (Levene's $F_{(5,469)}$=1.53, p=0.178).

The two way ANOVA detected a significant main effect of dream type ($F_{(2,469)}$=11.703, p<0.001, effect size=0.048) but the main effect of media access was not statistically significant ($F_{(1,469)}$=1.153, p=0.284).

A significant interaction between dream type and age group was discovered ($F_{(2,469)}$=3.511, p=0.031, effect size=0.015). Planned contrasts revealed that while the effect of dream type was significant for both groups examined ($F_{(2,469)}$=6.911, p=0.001 for group with no access and $F_{(2,469)}$=5.405, p=0.005 for group with access to B&W media), there were some small differences. In the group with no black and white media exposure the visual aspects of

coloured and mixed dreams were remembered equally well ($p=0.789$), but were remembered significantly worse in black and white dreams ($p<0.005$). In the group with access to black and white media, the visual aspects of coloured dreams were recalled significantly better than of mixed and black and white dreams ($p<0.01$). The effect of media experience, however, was significant only for black and white dreams ($F_{(1,469)}=4.209$, $p=0.041$), with people who had contact with black and white media remembering the visual details of such dreams significantly better than the other group.

This means that while both groups are better at recalling the visual aspects of coloured dreams, the group that has had experience with black and white media rates their visual memories of black and white dreams higher than the group without such exposure. Figure 3 shows the pattern of the interaction.

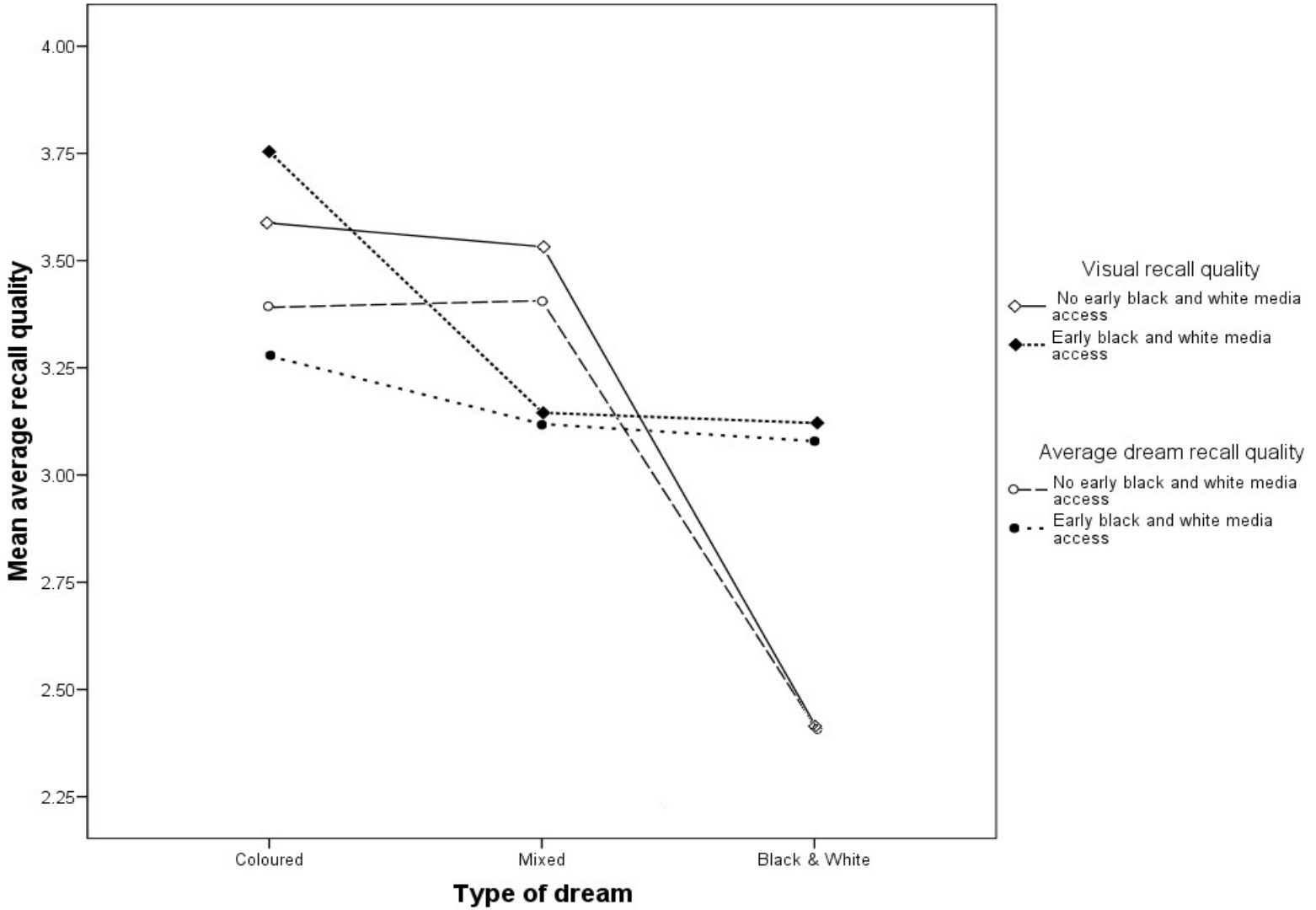
6.1.3.8 General recall quality

General recall quality was calculated by averaging the recall ratings for dream characters, scenes, actions and plot. Thus, it represented the memory of all non-visual aspects of the dream. When using the general recall quality as the independent variable in the ANOVA, Levene's test for equality of variances indicated that the error variances across groups were heterogeneous ($F_{(5,469)}=2.354$, $p=0.04$). However, a more detailed analysis revealed that this was due to a single outlier cell with a low mean and very low variance, and there was no correlation between cell means and standard deviations. Since Lindman (1974) has demonstrated that the F statistic is quite robust in these cases, it was decided to proceed with the analysis of variance The two way ANOVA detected a significant main effect of dream type ($F_{(2,469)}=5.359$, $p=0.005$, effect size=0.022) but the main effect of media access was not statistically significant ($F_{(1,469)}=0.371$, $p=0.543$).

There was a significant interaction between dream type and media access ($F_{(2,469)}$=3.037, p=0.05, effect size=0.013), which was broken down with planned interaction contrasts. The effect of dream type was significant only for the group with no black and white media access ($F_{(2,469)}$=5.509, p=0.005), but not for the other group ($F_{(2,469)}$=0.530, p=0.589). Thus, while participants with no black and white media access recalled colour and mixed dreams significantly better than black and white dreams, people who have had such access recalled all three types of dreams equally well. Furthermore, the effect of media access was significant only for black and white dreams ($F_{(1,469)}$=4.174,p=0.042), but not for coloured ($F_{(1,469)}$=0.534,p=0.465) or mixed dreams ($F_{(1,469)}$=1.50,p=0.221), with the recall of black and white dreams being superior in the group with black and white media access. Figure 11 on page 86 illustrates this interaction.

The finding that there are media access dependent differences in visual memory for greyscale dreams can be interpreted in two ways: either early exposure to black and white content enables people to encode and retrieve black ad white materials more efficiently or there might be some group differences in the experience of greyscale dreaming. The latter explanation is strengthened by the results of the second analysis. When the general memory of a dream is examined, there are no differences in recall quality between colour and black and white dreams for the group with access to black and white media. However, in the group with no early access to black and white media, coloured dreams are recalled significantly better than black and white dreams, and at the same time there are no group differences in recall for coloured dreams. These data are consistent with the hypothesis that people who have not experienced black and white media might label poorly remembered dreams as ‘greyscale’.

Figure 11: Interaction between type of dream and black and white media access for dream recall quality



Another unexpected effect was found for mixed colour dreams. These are supposed to be dreams in which only a couple of objects are coloured, and the rest is in greyscale. People who have not had sole access to black and white media recall mixed dreams in a pattern similar to coloured dreams while people with such access recall mixed dreams in the same way as black and white dreams. A possible interpretation for this discrepancy is a group difference in what is labelled as 'mixed colour' dream. It seems that in the former group, when only some of the colour information is recalled, colour dreams might be labelled as 'mixed', because a lack of memories about the colour qualities of the background is interpreted as greyscale background. The other group, on the other hand, might misremember some black and white dreams or insert a coloured object in a central place of the dream. Alternatively, one of these groups might experience genuine 'mixed colour dreams', and one of the ways of finding that out would be to study how mixed colour pictures are recalled when compared to colour and black and white pictures.

6.1.4 Conclusions

The most vital finding of this study is the strong age difference in the reporting of greyscale dreams, since it provides a sense of continuity between studies of the 1950's and the present results and confirms the findings of Stepansky et al. (1998). The generation who was reporting predominantly greyscale dreams in the early 20th century studies is still experiencing high levels of greyscale dreaming (when compared to current university students) which provides a unique opportunity to investigate this phenomenon and raises new questions regarding the stability of the influence of black and white media. The remaining conclusions from this study can be summarised in three sets: methodological insights, potential causes of

the cohort difference and finally the relationships between dream recall quality and dream colour in different age groups

The methodological conclusions from this study point to the preliminary reliability of questionnaire information when compared to dream diary estimates of dream colour. This result is by no means indisputable, mostly due to the specific order in which the questionnaire and diary were administered; some of the similarity between diary and questionnaire might be caused by people's desire to remain consistent in their responses. There is also the issue of the very simplistic data gathered in the questionnaire (4 choices of dream colour) and the short sampling time for the dream diary that might obscure the actual differences between how people usually respond in a dream diary and a questionnaire. Nonetheless, the idea of questionnaires being a reliable source of information about dream colour needs to be pursued further by creating better questionnaires and through more studies that compare questionnaire data with dream diaries.

When the possible causes of the cohort difference in reported dream colour were analysed, age did not turn out to be as important as the influence of black and white media – especially the access to black and white media before coloured media. The older participants who had started with coloured television had the same dream colour profile as the younger participants did, and those participants (only in the older cohort) who spent a few years of watching only black and white media reported having more greyscale dreams than the rest of the group. This finding is important because it weakens the ageing explanation of greyscale dreaming in the older cohort (lack of colour explained by memory and attentional changes) and provides support for the media influence hypothesis. At the same time, it introduces additional questions: why is the influence of black and white media so long-lasting despite lack of new input?

Finally, the analysis of the relationship between self-assessed dream recall quality and dream colour type provided additional support for the hypothesis that black and white media is a causal factor in greyscale dreams. The interaction between media experience, dream colour and dream recall quality points out that people with experience with black and white media recall their greyscale dreams as clearly as colour ones, which is not true of the remaining group. This divide in how dream recall and dream colour interact is interesting, because it suggests that while individual factors such as dream recall ability and visual memory do have an effect on how recalled dreams are classified in terms of colour, they are more important in people who have no environmental reasons to experience greyscale dreams. Figure 12 on page 90 displays the findings of this study in a visual form, highlighting the discovered relationships between the investigated variables and dream colour.

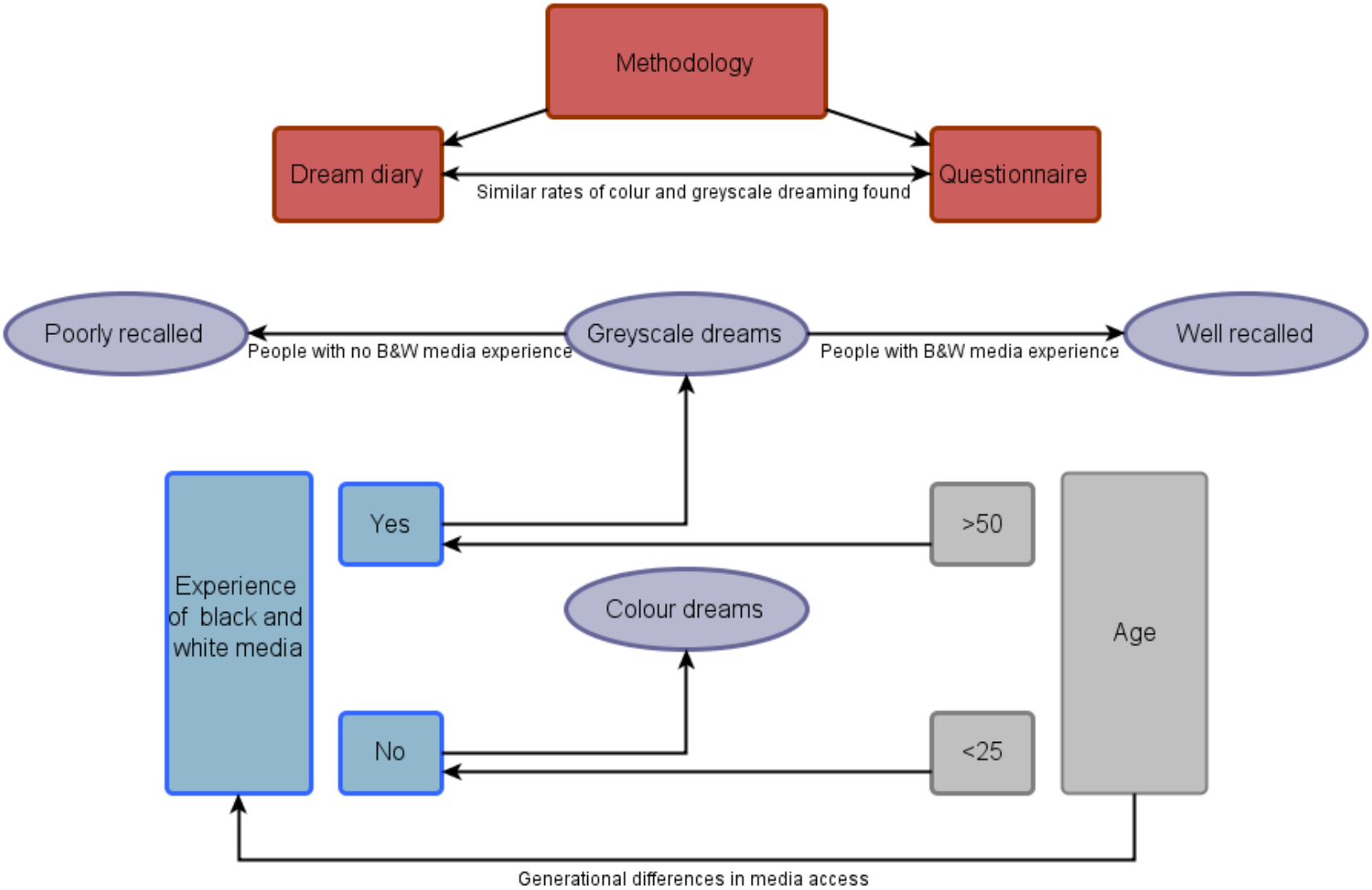


Figure 12: Overview of the main findings in the first study.

6.2 Experiment 2: Survey of colour in dreams

6.2.1 Objectives and hypotheses

The main aim of the second study was to investigate the prevalence of greyscale dreams in a wider university population. The previous study established the presence of age differences in the reported colour of dreams and a wider investigation of the frequency of greyscale dreams was in order. The secondary aim of this short study was to see if the relationship between dream colour, age and media experience can be replicated in a different format and in a wide group of middle aged adults. The main hypotheses were that there would be a correlation between age and the amount of greyscale dreaming, and that there would be a correlation between the different measures of access to black and white media and the amount of greyscale dreaming. The corollary hypothesis was that the correlations between media experience and dream colour would be stronger than the relationship between age and dream colour. Additionally, a new type of questionnaire for self-rating of dream colour was developed, and this study was designed to test how well this instrument could gather data.

6.2.2 Method

6.2.2.1 Design

The study used the correlational approach and employed a questionnaire to assess dream colour. The dependent variables were the reported frequencies of coloured and greyscale dreaming. The independent variables were the age of first access to coloured and black and white media as well as the time spent with black and white media only.

6.2.2.2 Participants

130 people completed the questionnaire, 33 men and 75 women. The average age was 47 (range 27-71, SD=6). The participants were recruited through University of Dundee email advertisements distributed to all students and staff members. Interestingly, few young adults responded to the advertisement, and the vast majority of participants were people over 40 years of age.

6.2.2.3 Materials

The main instrument used in this study was a questionnaire measuring dream colour and media experience. The aim of creating this questionnaire was to improve on the original instrument used by Middleton (1942) and Schwitzgebel (2006) by presenting the participants with a more refined way of indicating how their dreams are coloured and how well they can recall this information.

The questionnaire consisted of two main parts. In the first part, questions about the frequency of different types of dreams were asked. The participants indicated if they experience coloured, greyscale and mixed dreams (yes or no items) and then rated how certain they were of this (on a 1-7 scale, with 1 = guessing, and 7 = confident). The confidence rating was introduced because in the previous study, a lot of the participants had expressed uncertainty in assessing their dream colour, especially in regard to greyscale dreams. Giving the participants a way to formally quantify that uncertainty could result in more reliable data. The separate confidence ratings for each dream colour type were used to find out whether there are indeed any particular dream types that people have problems judging. After providing the answers with confidence ratings, the participants were asked to provide an estimate of what percentage of their dreams in coloured, greyscale or a mix of both. While the

accuracy of such self-assessment is by no means perfect, it does provide a measure of dream colour type that is more valuable for analysis than the simple yes-no answers. The questionnaire also asked the participants to answer if they could recall a particular dream in each colour mode (yes/no answer). This was introduced as an additional confidence measure – participants' assessment of their own dream colour can be seen as more trustworthy if they can actually recall a dream with a particular colour mode. Finally, the last item of the questionnaire asked the participants to judge if their dreams had changed significantly during their lifetime. The participants were given the options to state that they experienced more coloured, more greyscale and more mixed dreams, along with an answer that stated they could remember less about the dream colour in general. This question was aimed at identifying colour changes in the older respondent's dream life, and while the reliability of such self-assessment is rather weak, there is no other way of gathering such data, except for analysing longitudinal dream journals that span at least 20 years.

The second part of the questionnaire inquired about the participants' experience with black and white media. The responders were asked to provide an estimate of the age of first regular contact with black and white TV and cinema, and colour TV and cinema. The questionnaire can be found in Appendix 4.

6.2.2.4 Procedure

The questionnaire was placed online at the university website. Before starting, all participants read the information sheet and understood that by completing the questionnaire they were providing their consent for the study. The questionnaire was completely anonymous and no identifying data were requested from the participants.

6.2.3 Results

6.2.3.1Reported colour in dreams

In 7 cases the participants filled the questionnaire out in such a way that the sum of the percentages of their dream types was over 100%. In such cases, their responses were transformed to keep the proportion of dream types intact, while maintaining the 100% sum.

In the unselected sample, 93 % of the participants indicated they experienced coloured dreams. In that subgroup, the average percentage of dreams reported as coloured was 69% (SD=38%). Notably, 84% of those participants could, at that point of time, recall a coloured dream they had and the average certainty rating for the experience of coloured dreams was 5.7 (SD=1.9). 34% of the people also indicated they experienced black and white dreams, and the percentage of greyscale dreams reported in that group was 40 (SD=30). The average certainty for the judgement of having greyscale dreams was 4.7 (SD=2.1), lower than for colour dreams, and from the people who indicated they have greyscale dreams 61% said they could remember such a dream. In the case of mixed dreams 30% of participants indicated they experienced such dreams, and the average percentage of mixed dreams was 32% (SD=34%). The average certainty rating for having mixed dreams was 4.6 (SD=2.2) and in the group that claimed to experience such dreams 58% of people said they could recall a mixed dream at the time of answering the questionnaire. There were no correlation between the percentages of coloured or greyscale dreaming and age. Table 5 on page 95 shows an overview of the data.

Table 5: Experience of various dream colour types

	Colour dreams	Greyscale dreams	Mixed dreams
Percentage of participants experiencing this mode of dreaming	93 %	34%	30%
Average confidence rating (1-7 scale)	5.7	4.7	4.6
Average percentage of dreams that are in this colour mode	64%	13%	8%
Average percentage of dreams that are in this colour mode (for participants who said they experience these types of dreams)	69%	40%	32%
Percentage of participants who can recall a dream in that colour mode (for participants who do experience these types of dreams)	84%	61%	58%

A repeated measures ANOVA was carried out on the confidence ratings to explore whether people are more confident in making judgements about any particular dream type. The confidence ratings were not intercorrelated (Mauchly's test of sphericity p=.133) and there was a significant effect of dream type on confidence ratings ($F_{(1,63)}$=9.683, p=.003). When pairwise comparisons were carried out, each within-subject factor was significantly different from the others (coloured vs. mixed dreams confidence p=<.001; mixed vs. greyscale dream confidence p=.016; greyscale vs. coloured dream confidence p=.003). As it can be seen from Table 5, people were most confident when rating their experience of coloured dreaming, followed by greyscale dreaming, with their confidence in the ability to judge their experience of mixed dreaming coming at the last place.

6.2.3.2Age of media access

Since there were no detectable age-related differences in the colour of dreams, media access was brought into the analysis. The average age of first regular access to any black and white media was 4.7 (SD=3years), which could be subdivided into black and white movie access (mean age=6.3, SD=4years) and TV access (mean age=5.1, SD=4years). The average age of first access to any colour media was 9.5 years (SD=5), with access to colour movies appearing earlier (mean age=9.7, SD=5 years) than regular access to a colour TV (mean age=12, SD=6 years). The average time spent with black and white media only was 5 years (SD=4).

6.2.3.3 Correlations

First, correlations between measures of black and white media experience and dream colour were computed for the unselected group of 108 participants. There were no significant correlations between percentage of coloured or greyscale dreams and either length of black and white media experience or first age of access to colour media. Table 6 on page 97 shows the coefficients.

Because no predicted relationships emerged from the data, the confidence ratings were put into the analysis. The difficult nature of judging one's dream colour accurately in a questionnaire administered during daytime (as discussed in chapter 3 and 5) can lead to a lot of guessing on the participant's behalf. Additionally, the questionnaire was administered online, with no way of controlling how much time and attention the participants spent on their answers. It was plausible that many of the volunteers did not provide self-report data accurate enough to allow for the detection of rather small effect sizes.

Table 6: Correlations of media experience and dream colour

	Age	Age of first regular access to colour media	Years spent with black and white media only
Percentage of coloured dreams	r=.054 p=.582	r=-.113 p=.250	r=-.030 p=.764
Percentage of greyscale dreams	r=-.012 p=.908	r=087 p=.385	r=.100 p=.323
Percentage of mixed dreams	r=.037 p=.714	r=.044 p=.669	r=.079 p=.442

Therefore, a selection of cases in which the confidence ratings for each type of dreams were above 4 (on a 1-7 scale) was created, leaving 47 participants who were reasonably confident about their dream colour judgements. There were 33 women and 15 men in this subgroup, and the average age was 46 years (SD=5). The average age of gaining regular access to black and white media was 4 (SD=3), for coloured media was 9 (SD=4), and the average time spent with black and white media only was 5 (SD=4). Overall, the age and media access characteristics in this subgroup were nearly identical to the larger group.

When the correlations were computed using the selected sample, the correlations between age and dream colour were still not significant. However, a significant relationship between the percentage of greyscale dreams and time spent with black and white media only (r=.328, p=.028) emerged. This finding needs to be treated somewhat cautiously, since the size of the group is smaller and the mechanisms of confidence ratings may not be as straightforward as described.

6.2.4 Conclusions

The major findings from this study can be summarised in three points. Firstly, while the vast majority of adults experience coloured dreaming (93%), there is a significant portion of the population that reports having greyscale dreams or dreams that mix colour and greyscale elements. Moreover, for those people who say they experience greyscale dreams, these dreams constitute around 40% of their dream life. Because the study was based on a self-report daytime questionnaire, there is no way of addressing whether these values are an accurate reflection of the actual dream experiences, or are a result of the distorting factors discussed in the introductory chapters. Individual differences in memory for dream content and for colour, along with the attentional and cultural biases are the prime candidates for the reasons behind people's misjudging their dream colour. Nonetheless, this result is quite valuable as a reflection of what middle-aged and older adults report about their dream life.

Secondly, the finding that age is not related to the reporting of coloured or greyscale dreaming is of importance here. One of the main explanations proposed for the group differences in study 1 were the obvious age differences between the two groups. The literature on the effects of ageing on memory and dreaming suggested that age changes do not have the potential to be a strong factor in determining the colour of dreams – and this study has presented more evidence for this prediction. Moreover, the analysis carried out on the high-confidence data once again suggested that the length and age of access to black and white media have an influence on the type of dreaming reported, similarly as in the first study.

The third main finding is how confidence ratings can have an influence on the variable relationships in the data. The hypothesised relationship between length and age of media access did not materialise in the data from the whole sample – but it could be found when only the participants who were quite confident in their responses were taken under

consideration. As discussed in the introductory chapters, there are numerous reasons why people are poor at recalling dreams, and why one-time daytime inquiries into people's dream life have a tendency to yield inaccurate results. Using a simple confidence rating can sift out some of these issues – such as, in the case of dreams, the responder not paying attention to their dream colour and having to guess when filling out the questionnaire – providing data that are more reflective of the actual dream colour pattern. A comparison of the questionnaire and diary estimates of dream colour that correlates the differences between the two with ratings of confidence is be a good way to investigate whether confidence can be truly useful variable (and is carried out in study 7). Figure13 displays the relationships between the main variables discovered in this study.

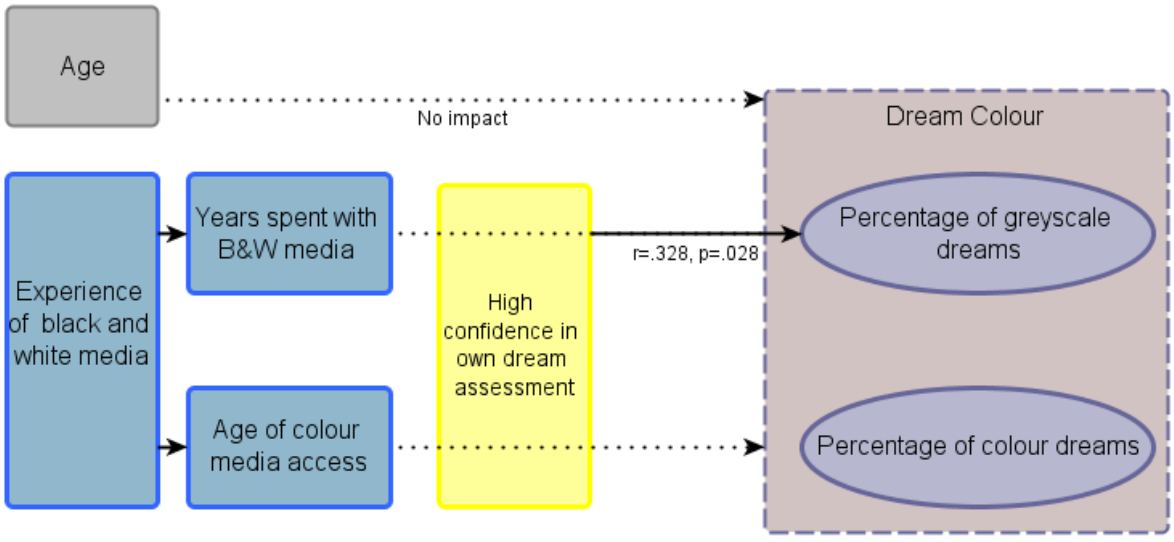


Figure 13: Overview of the findings of study 2

6.3 Experiment 3 – Age differences in colour memory and imagery

6.3.1 Objectives and hypotheses

The previous two studies explored age and the accompanying early influence of black and white media as the framework for explaining greyscale dreaming. While the results of those studies did provide come support for the idea that black and white media had an impact on dream colour, they also uncovered that considerable within group variance in the reporting of coloured and greyscale dreams exists that cannot be accounted for by invoking media access or methodology. This study was designed to investigate the factors that might impact the individual differences in the reported dream colour, namely visual imagery and visual memory abilities (as discussed in chapter 4). The first major aim of this study was to find out if individual differences in memory for colour play any role in the reported dream colour. This study introduced two new approaches to the study of visual memory – it compared the memory abilities of two age groups and employed an incidental memory task. The previous studies that looked at visual memory and dreaming used explicit memorising tasks, which might not be adequate for the context of dream recall. A narrative task was thus constructed, in which the participants saw series of thematically linked images and had to title the series – and after a short delay recall which slideshow was presented in colour, and which was black and white. The hypothesis was that memory for colour would be positively correlated with the reported frequency of coloured dreaming.

The second objective of the study was to find out whether the prevalent colour of dreams, as reported with a questionnaire, can be related to the individuals' visual imagery preferences. The main hypothesis was that there will be a positive relationship between object imagery abilities and reporting of coloured dreams. A secondary hypothesis was that spatial

imagery abilities would be positively correlated with greyscale or mixed dreams. To complement the self-report measure of visual imagery preferences a separate measure of purely colour imagery was developed and introduced, basing on the grain size task used in a paper investigating the OSIQ questionnaire properties (Kozhevnikov, Kosslyn and Shephard, 2005). This task measured the participants' ability to accurately visualise colours of common objects without external input. It was hypothesised that people with better accuracy in colour visualisations should report more coloured dreams.

Additionally, the relationship between age, media experience and dream colour was once again investigated. This study employed a similar group comparison methods as the first study did, while using only a questionnaire assessment of dream colour. It was hypothesised that the older age group would report more greyscale dreams than the young group and that there would be a link between measures of black and white media access and the frequency of greyscale dreaming.

6.3.2 Methods

6.3.2.1 Design

This study was based on a correlational and between groups design. The main variables investigated were age, experience with black and white media and colour of dreams as reported in a questionnaire. Additional factors included memory for the presence of colour and visual imagery style preferences.

6.3.2.2 Participants

39 people took part in the study, 19 aged 25 or less and 20 people aged over 50. There were 12 men and 27 women in the group. The average age in the younger group was 21.4 (SD=2.06) and in the older group was 55.3 (SD=11.4). The participants were recruited

through the University of Dundee and through local newspaper advertisements. Since the study involved a surprise memory task, the participants were not informed that they are taking part in a study of colour in dreams, but were instead told that the research concerns age differences in picture description. The participants were paid £4 for their contribution.

6.3.2.3 Instruments

Dream colour and media experience questionnaire

The questionnaire used in this study was identical to the one introduced in study 2 (and available in Appendix 4). The participants were asked a series of questions related to dreaming in full colour, greyscale and in mixed colour: whether they experience these types of dreams at all, how certain they were of their answer, what percentage of their dreams was in that colour type and whether they could remember a particular dream in that colour type at the moment of testing. Thus, this instrument could measure the predominant colour of dreams as well as confidence ratings and the recall of particular dream types.

The questionnaire also included items that estimated their experience with black and white media, as the participants were asked to provide the age at which they gained first regular access to black and white TV and movies as well as colour TV and movies. From this, both the age of first access and the length of access to colour and black and white media could be calculated.

Memory for colour

The majority of colour memory tasks used in the literature (Schredl et al. 2008) are explicit memory tasks that examine people's ability to recall the particular colour of an item presented in a picture. This does not correspond well with the task that the dreamer undertakes when

trying to recall the presence of colour in a dream, especially that usually no conscious effort to remember dream details is made during the encoding phase. The task used in the present study was constructed to overcome these face validity issues. 18 short slideshows, each consisting of 7 photographs were created using freely available photos. The photos were assigned to the slideshows basing on an overall common theme, such as 'festiveness' or 'activity'. Half of the slideshows contained photos of people and objects and the other half were composed of objects and sceneries only. This was done in order to provide participants with a substitute hypothesis for the study, as they were told the study examined the relationship between the ease of slideshow naming and the presence of animate actors or people in the photographs. The slideshows were also balanced in terms of the colour intensity and salience. Four of the slideshows were composed of photographs with bright and salient colours, another four contained only photos with low colour intensity and a restricted palette, and the remaining eight were composed of photographs with medium colour intensity. A colour and greyscale version of each slideshow was prepared, and the participants were shown half of the slideshows in colour, and half in greyscale. Each slide was shown for 3 seconds, and the participants were asked to say a word in response to the stimuli (either name the object or the situation presented). After each slideshow, they were asked to think of and write down a title for the sequence of photos, and rate how difficult it was for them to create that title. After seeing all the slideshows, they were given a series of questionnaires and other tasks to complete. After 20 minutes, they were given a surprise recall task – they were presented with the list of titles they generated, and were asked to recall which slideshows were in colour and which ones were in greyscale. The participants were encouraged to guess, if they could not recall anything. When they completed this task, a recognition task was presented. Two photographs from each of the slideshows were selected for a total of 36

pictures shown. Each photograph was shown in colour and greyscale side by side, and the participants decided which one they remembered seeing. The participants were asked to respond as quickly and accurately as they could. One of the photograph series that was used for the slideshows (in colour and black and white versions) is available in Appendix 5.

Colour imagery test

A novel task was designed to measure colour imagery abilities, basing on the perceptual grain size task developed by Kozhevnikov, Kosslyn and Shephard (2005), and analogous to the colour imagery task used by Goldberg et al. (1989). A list of colour comparison questions for various objects with a relatively stable and yet not too characteristic colour was generated. Example items would be 'Which item is darker: a pound coin or a penny coin?' or 'Which one has more red in it's colour: carrot or butternut squash?'. This list was presented to 10 native English speakers who answered the questions and provided any feedback regarding any possible problems with the items and the colour comparison. 22 items with highest agreement rates were picked out for the final instrument. There were 2 items concerning light-dark judgements, 4 items concerning greenness, 6 items concerning redness, and 5 items concerning whiteness and yellowness each. A forced choice task was created from these items using Superlab software. First, the question for each item (for example 'which item is darker') would be displayed on a white screen for the participants to read in their own time. After they felt they read and understood the question, the two comparison items could be brought up by clicking any mouse button. This allowed for a separation of question reading time from item reading and response time. The two items to compare were then displayed below the question, and the participants would respond by pressing the corresponding mouse button to indicate which item fits the criteria – the one presented on the left or on the right. Additionally, 5

semantic decision tasks were included in order to have a measure of general decision and reaction speed, without the visual imagery component. The full list of items is available in Appendix 6.

Visual imagery style

The Object Spatial Imagery Questionnaire (as developed by Blajenkova, Kozhevnikov and Motes, 2006) was used to estimate individual preferences in visual imagery style. This instrument was selected because it does not simply assess visual imagery, but also separates it into two components that have been shown to be neurologically and functionally separate – spatial and object imagery. Additionally Marks' Vividness of Visual Imagery Questionnaire (Marks, 1973) was used as a secondary imagery assessment tool that would provide a more general overview of visual imagery abilities. Both instruments can be seen in Appendices 7 and 8 respectively.

6.3.2.4 Procedure

The participants were tested at the University of Dundee by the experimenter. After reading the study description and signing the informed consent form, the participants were given the colour memory task disguised as a picture naming task. Then, they were given two visual imagery questionnaires to fill out – the OSIQ and the VVIQ. Afterwards, they carried out the colour imagery task, and the experimenter made sure that the time since finishing the colour memory task was 20 minutes for each participant. At this point, the participants were informed about the true purpose of the study and were given the option to withdraw if they wished to. All participants decided to go ahead, and they were then given the recall and recognition tasks, followed by the dream colour questionnaire. The participants were fully debriefed at the end of the study and received £4 for their time.

6.3.2.5 Analysis

The data from the study were analysed using correlations and between group t-tests. When age differences were deemed a possible factor, separate correlation coefficients were calculated for the two age groups.

6.3.3 Results

6.3.3.1 Sex differences

Variables such as dream recall frequency and report length are related to the sex of the dreamer, with females recalling more dreams than males (Giambra, Jung and Grodsky, 1996) The spatial and visual imagery variables also often show sex differences (Casey, Winner, Brabeck and Sullivan, 1990) which might have an impact on the relationships between imagery and dream colour if there are independent sex differences in dream colour. Therefore, the data was analysed for potential sex differences. No such sex differences were found in the frequency of experiencing the three dream colour types. There were also no sex differences in the OSIQ variables in this sample or in the VVIQ score, although the difference in Spatial Imagery was approaching significance ($t_{(37)}$=-1.651, p=.107).

6.3.3.2 Age differences in dream colour

Independent t-tests were carried out to find out about any age differences in the reported frequency of the three dream colour types. There were no significant differences in the percentages of either coloured dreaming ($t_{(37)}$=1.4, p=.165), greyscale dreaming ($t_{(37)}$=-1.6, p=.117) nor mixed dreaming ($t_{(37)}$=0.24, p=808). Table 7 on page 107 shows the means and standard deviations calculated for the two age groups. No significant differences emerged

when only the 31cases with average certainty above 3 (certainty for the experience of three colour types of dreaming was measured on a 1-7 scale) were analysed.

Table 7: Overview of the age differences in dream colour

	Age under 25		Age over 50	
	Mean	SD	Mean	SD
% of colour dreams	66.8	36.1	49.7	39.3
% of greyscale dreams	17.9	25.9	34.2	36.2
% of mixed dreams	13.2	16	11.6	22.9

6.3.3.3 Media experience

The relationship between early black and white media exposure and the colour of dreams could not be calculated on a similar basis as in the first study due to the fact that all participants in the older age group had first access to black and white media before gaining regular access to colour media. Instead two measures were used: the length of sole black and white movie access and the age of access to colour media, and their correlations with frequency of coloured and greyscale dreaming were calculated within the older age group. There were no significant correlations between length of black and white media access and the frequency of coloured (r=.347, p=.134) or the frequency of greyscale dreams (r=-.304, p=.192). The first age of access to colour media was also not related with either colour dreaming (r=.166, p=.485) or greyscale dreaming (r=-.204, p=.388). Removing the cases with average confidence rating below 3 did not yield any different results.

6.3.3.4 Memory for colour

The initial analysis pertained to any age differences in colour memory. There were no age differences in the overall percentage of slideshows with correctly recalled colour ($t(35)=1.400$, $p=.170$)), with the older group correctly recalling the colour of 75% of the 18 slideshows, and the younger group recalling 72% correctly. However, there was a significant age difference in the recall of black and white slideshows ($t_{(35)}=2.541$, $p=.016$), with older participants mistakenly attributing colour to them in 53% of the cases, as compared to 38% in the younger group. There were no age differences in the mistakes made with the colour slideshows, with 86% and 75% items correctly recalled by the younger and older groups respectively ($t_{(35)}=-0.337$, $p=.708$).

More predictably, significant age differences appeared in the recognition task ($t_{(37)}=2.06$, $p=.047$), with the younger group correctly choosing the previously presented version in 83% of the trials, as compared to 76% rate for the older group. There were no significant differences in the correct recognition rates for black and white photographs ($t_{(27)}=1.225$, $p=.228$) between the older (74%) and the younger (79%) groups, but the difference in coloured photo recognition approached significance ($t_{(37)}=1.746$, $p=.089$), with the younger group correctly choosing the coloured image in 86% of the cases, and the older group doing so in 78%.

Separate analysis of the two age groups did not yield any significant correlations in either group. Since age differences in the memory for colour appeared only for the recognition task, and the recall and recognition effects went in the opposite directions, the two age groups were merged to investigate the relationship between the overall recall and recognition colour memory and the frequency of coloured and greyscale dreaming was carried out. There were no significant correlations between the percentage of reported colour dreaming and either

recall (r=.163, p=.334) or recognition (r=.550, p=.783). The reported percentage of greyscale dreaming was not significantly related to recall (r=-.270, p=.105), although the relationship approached significance, and recognition was similarly unrelated (r=-.045, p=.784).

6.3.3.5 Visual Imagery

There were no age differences in the score for the VVIQ instrument ($t_{(37)}$=0.263, p=.794), so a simple correlation between the score and frequency of different types of dreaming was calculated. However, there was no relationship between the VVIQ score and either coloured dreaming (r=0.096, p=.561), greyscale dreaming (r=0.017, p=.919) or mixed dreaming (r=0.143, p=.386).

Age differences in the object and spatial scores were computed and it was found that the object score differences approached significance ($t_{(37)}$=1.68, p=.100) with the younger group scoring 3.6 on the object scale as compared to 3.3 in the older group. There were no significant differences in the spatial imagery scores ($t_{(37)}$=0.384, p=.703).

Correlations between the two imagery scores and reported frequencies of different dream types were calculated. Table 8 shows the correlation coefficients for these variables.

Table 8: Correlation coefficients between imagery preferences and dream colour

	% of coloured dreaming	% of greyscale dreaming	% of mixed dreaming
Object imagery score	r=.361* p=.024	r=-.224 p=.132	r=-.191 p=.245
Spatial imagery score	r=-.126 p=.445	r=-.083 p=.616	r=.410* p=.010

There was a significant positive correlations between object imagery score and frequency of coloured dreaming (r=0.361, p=.024) and a significant positive correlation between frequency of mixed dreaming and spatial imagery score (r=0.410, p=0.010). When separate calculations were made for the two age groups were calculated, these correlations disappeared in the younger group, but in the older group the object imagery-colour dreaming relationship remained significant (r=0.460, p=0.041) and so did the object imagery-mixed dreaming correlation (r=0.471, p=0.036). In fact, the correlation magnitude actually increased in the older group. The scatterplots that present this difference in correlation patterns are available in Appendix 18.

6.3.3.6 Colour imagery

As this instrument was never used before, its overall results were initially analysed. The mean proportions of items correct was 77% (range 50-90%, SD=10%). The average RT for items asking for colour comparisons was 2540ms (range 1136-5713ms, SD=885) and when the RT for semantic items was subtracted from individual scores the average colour decision RT was reduced to 900ms (range 25-2490ms, SD=567ms). An item by item analysis of errors showed that in one case (red comparison item) the average reaction times were above average (RT=7114) and subsequently this item was removed from the analysis.

The relationship between speed and accuracy for each item was also investigated, and it was discovered that there was a significant negative correlation between the number of participants who provided the correct answer and the average reaction time for the items (r=-.520, p=.016). This would mean that the longer people spent on the item, the less likely it was that their answer would be correct. This effect could be explained by item difficulty that

ensured that the participants spent more time considering the items that were very close in terms of colouring and were thus harder to answer correctly.

There were no significant age difference in the percentage of items correct ($t_{(37)}$=-1.80 p=.080), with the older group correctly answering 80% of items, as compared to 74% in the young group. There were also surprisingly no age difference in the reaction times, with the older group averaging a 2515ms reaction time and the younger group responding in 2153ms ($t_{(37)}$=-1.46, p=.152).

Pearson's correlations were computed for the colour imagery score and the two imagery variables from OSIQ. It was found that both the average reaction time and the reaction time with the semantic decision time subtracted were negatively correlated with Object Imagery (r=-.402, p=.011 and r=-.369, p=.021 respectively). At the same time, the percentage of items correct was strongly negatively correlated with Spatial imagery score (r=-.414, p=.009). These results suggest that the colour imagery instrument behaves according to expectations and does tap into colour imagery abilities.

When the reaction times and accuracy in the colour imagery task were compared with the types of dreams experienced, no clear links were found, however. The table below presents the correlations between the dream type proportions experienced and the results of the colour imagery task.

Table 9: Correlations between Colour Imagery and dream colour

	Proportion of colour dreams	Proportion of greyscale dreams	Proportion of mixed dreams
Reaction time	r=-.306 p=.058	r=.043 p=.797	r=-.024 p=.886
Percentage of items correct	r=-.064 p=.697	r=.154 p=.349	r=-.173 p=292

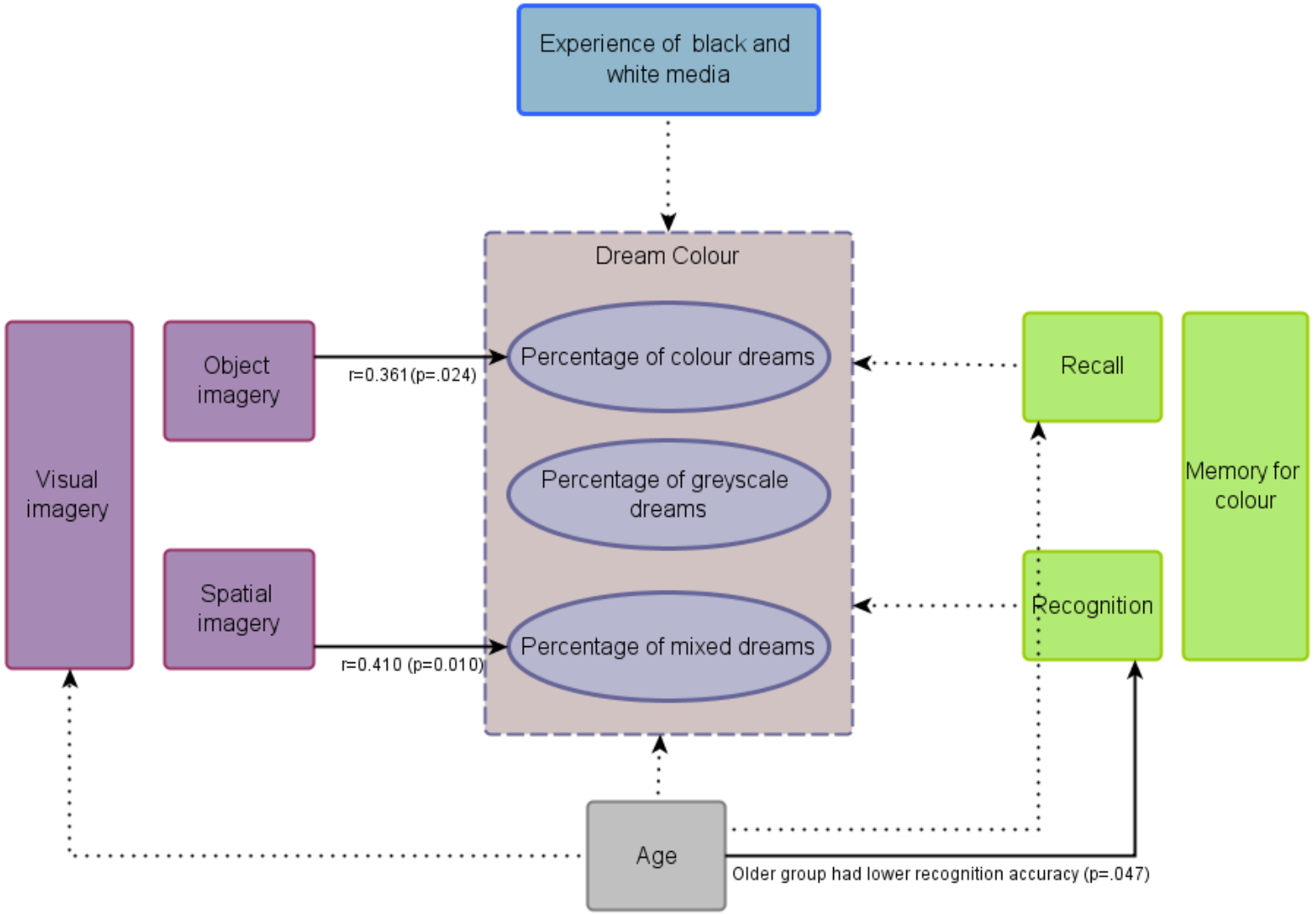
6.3.3.7 Colour memory and imagery

The relationships between the various measures of imagery and memory for colour were also investigated. The VVIQ questionnaire scores were not related either to Object or Spatial scores, and were not related to any task measures of colour memory or colour imagery. The Object and Spatial scales from the OSIQ questionnaire were, on the other hand extensively connected with other measures. The Object imagery score was strongly correlated with the recall task score in the memory for colour task ($r=.406$, $p=.013$). What is interesting, when separate analyses were carried out for the two age groups, this relationship disappeared in the older group ($r=-.005$, $p=.984$), and became stronger in the younger population ($r=.801$, $p<.001$). The scatterplots for each OSIQ variable and recall task scores are available in Appendix 18.

6.3.4 Conclusions

This study was created with two main aims – introducing the individual differences in colour memory and imagery into the research question and gaining further support for the media experience hypothesis. Figure 14 on page 112 presents the main findings of this study. The first line of investigation proved to be very fruitful and three main conclusions could be drawn from the data.

Figure 14: Overview of the main findings for study 3



Firstly, in this sample of older adults there was a significant relationship between visual imagery preferences and dream colour. Higher object imagery score was related to more colour dreaming, which is in line with the possible mechanisms of influence discussed in chapter 4. People who are better at visualising colours and detailed pictures should recall, and perhaps even experience more vivid and coloured dreaming. The second correlation between the percentage of mixed dreaming and spatial imagery score was a bit more unexpected, although it still fits very well into the general explanation of how imagery styles might work on reported dream colour. People with higher scores in spatial imagery are often described as focusing on the rough sketch of the visual scene they are investigating, and therefore might notice details such as colour only when they are very salient. In terms of dream generation, it is plausible that spatial imagers either simply do not generate enough visual details to provide the dream with full colour or do not notice the colours, resulting in dream reports that are then categorised by them as a mixture of colour and greyscale. Unfortunately, it is currently impossible to distinguish whether spatial imagers' reporting of such dreams is a result of dream generation or visual recall issues. Another issue with this result is the lack of significant correlations between OSIQ and dream colour in the younger subgroup. If visual has a genuine impact on the generation or recall of dreams, this should be detectable in the whole population and future studies should strive to establish whether this is indeed the case.

The second main result was the interesting pattern of age differences in colour memory. One of the age related explanations for greyscale dreaming was that older people would misinterpret their coloured dreams as greyscale because they have a (possibly culturally influenced by black and white media) tendency to classify poorly remembered images as black and white. This study has shown that is not the case – in a test of incidental colour

memory older participants were just as accurate as the younger ones in free recall, and when the errors were analysed, it was found that the older group actually had a tendency to misrecall the black and white slideshows as coloured. When recognition or images from slideshows was measured, however, the expected pattern of age differences emerged, with the older group being a bit worse at image colour recognition. This mixed result is not entirely unexpected, since the available research on age differences in visual memory is inconsistent at best and there is no research on colour memory in particular. The difference between recall and recognition results can be seen as a result of the different cognitive strategies both measures of memory tap into. The recall task required the participants to go back to the slideshow titles they invented and try to remember any details that could tell them whether the slideshow was in colour or not. Performance was highly dependent on the effort placed in slideshow interpretation and on individual techniques in attributing meaning – something age does not change. The recognition task was timed, on the other hand, and measured quick and accurate identification which does decline with age. The thing to keep in mind is that for the purposes of dream colour recall, the free recall task is probably a more valid measure of colour memory.

The third major finding was the lack of predicted correlations between colour memory and the colour of dreams. It was hypothesised that people with poorer memory for colours should report more greyscale dreams, which was not the case in this study regardless of which measure of colour memory was used. Because of the small sample size this lack of results needs to be taken with caution and it is likely that the present study design simply did not have sufficient power to uncover the hypothesised relationships. The nearly significant negative correlation between colour recall and greyscale dreaming is suggestive of such an option. On the other hand, if memory for colour is indeed not a factor in greyscale dream

reporting, the reality of such experience would have to be considered with more seriousness. The fact that in the current dataset self-reported visual imagery preferences (which to an extent also relate to memory for colour and detail) were predictive of dream colour while colour memory as such was not strengthens the idea that dreams might be generated in greyscale, or at least with fewer colour details than we would expect from the waking world, in the absence of neurological injury.

The second set of hypotheses, regarding age and media experience influence was not supported. This was most likely due to the smaller sample size that might have obscured the between-group differences (due to the high within-group variability). Moreover, this study employed a questionnaire as opposed to a diary (like in study 1) thus introducing extra variance that might have overshadowed any detectable media effects. Because the sample size was quite small, it was impossible to prune out the cases in which people expressed low confidence in their estimates of dream colour frequency. The fact that the use of a questionnaire probably hindered the discovery of media effects does not speak in favour of questionnaire reliability. While the overall match between what is reported in diary and questionnaire might be adequate (as study 1 suggested) the increased variance introduced through questionnaire measure might necessitate increasing sample sizes is the same effects are to be reliably uncovered. Finally, the particular composition of the older group did not allow for the media access hypothesis to be tested appropriately regardless of any age effects.

6.4 Experiment 4: Visual imagery preferences and dream content

6.4.1 Objectives and hypotheses of the study

The research carried out in study 3 provided preliminary support for the idea that visual imagery abilities are related to how people report (and perhaps experience) dreams. The relationship was, however, only found in the older age group, so a larger scale study of imagery and dream colour was deemed necessary to see whether those findings were an artefact. Apart from replicating the previous results, this study also introduces a new approach to the investigation of dream visual characteristics. The next logical step in this line of inquiry was to investigate whether the propensity to visualise in pictures or sketches can influence dream content itself. This question was important because it would help to pinpoint where exactly in the process between dream experience, dream recall and general dream colour assessment imagery preferences make the biggest impact. If the differences between spatial and object imagers can be traced in the descriptions of visual dream content –good object visualisers reporting more colours and visual details, and spatial visualisers focus on the spatial descriptions of space and movement, a very interesting area for new research would open. A ‘hard’ explanation of the hypothesised influence is that these differences stem from the dream generation process itself, which would mean that the imagery styles shape the way in which dreams are experienced. People with good object imagery skills simply generate more visual details in their dreams, and good spatial imagers’ dreams contain more dynamic and spatial elements. A ‘soft’ explanation only states that imagery styles influence only what elements of dream are remembered and later preferentially recalled in the dream report, and does not posit any differences in the dream material itself. Unfortunately, distinguishing between which of these two explanations is valid is currently impossible. If, however, there

are no differences between the dream descriptions of object and spatial visualisers, it becomes more likely that the relationship between imagery abilities and dream colour is limited to recall effects only. The primary aim of this study was to find out if visual imagery style can indeed have an influence on dream content through analysing the most recent dreams of university students.

The main hypothesis was that visual imagery style would have an influence on the visual elements of dream description. More specifically, it was hypothesised that object imagery ability would be correlated with the number of phrases that describe visual details and colours and that spatial imagery ability would be correlated with the number of phrases referencing movement and spatial details.

The secondary aims included replicating previous results regarding the relationship between imagery styles and general dream colour. It was hypothesised that high object imagers would experience more coloured dreaming and high spatial imagers would report more greyscale or mixed dreams.

6.4.2 Method

6.4.2.1 Design

The current study was based on a correlational design. The variables investigated were visual imagery style, recall of coloured and greyscale dreaming, experience with black and white media and visual descriptions in the dream report: visible objects, movements as well as spatial and visual detail. Because dream colour type was provided as a nominal variable, group comparisons were also planned.

6.4.2.2 Participants

The participants were recruited during 1st year psychology tutorials and were awarded one course credit for their time. 81 people participated in the experiment, and there were 62 women and 19 men in the group. The mean age in the group was 19.8 (SD=4.70).

6.4.2.3 Materials

The questionnaire used to gather data about dream colour and media experience was taken from the 1st study in this series (Appendix 1). Dream colour was judged by participants themselves who could choose that they dream 'in colour only' 'in greyscale only', 'both in colour and greyscale', 'neither' and 'I don't know'. The questionnaire also included items that estimated their experience with black and white media, as the participants were asked to provide the age at which they gained first regular access to black and white TV and movies as well as colour TV and movies. From this, both the age of first access and the length of access to colour and black and white media could be calculated.

Visual imagery preferences were assessed with the Object Spatial Imagery Questionnaire that had been used in study 3 (Appendix 7).

Dreams were collected using the standard 'Most Recent Dream' form taken from Schneider and Domhoff online Dream Research resource website (available at http://dreamresearch.net/Forms/most_recent_dreams.html).

6.4.2.4 Procedure

The participants were tested after class, in a group setting. They were informed about the purpose of the study, and handed study information sheets along with the questionnaire

and most recent dream form. The participants took as much time as they needed to record their dream, and handed in their completed forms to the experimenter. Typically, the study took between 10 and 15 minutes to complete. No identifying information was placed on the questionnaires, as the participants provided their names for course credit system on separate slips that were collected with the questionnaires and stored separately.

6.4.2.5 Coding

The handwritten dream reports were transcribed onto a computer and all extraneous text not relating to the dream content was removed – this included comments about a person's mood after awakening, or explanations of waking life circumstances that were related to the dream content. The coding consisted of counting up the numbers of times various visual types of information were found in the dream narrative. The categories were extracted from Fein et al (1985) paper and appropriate coding definitions were created. The 'Objects' category was the visible objects: these included all inanimate objects, specified parts of objects, buildings and parts of buildings or landscape. The 'Actions' category contained all dream actions that were visible to the dreamer. A special 'Visual action' category was introduced for the dreamer indicating his visual involvement with the dream environment. 'Spatial detail' category was used for phrases and words that depicted the spatial relationships between obje/cts or people in the dream, or the direction of movement or actions. Finally, 'Visual details' category contained all details of how the various objects or actions looked like. A separate subcategory was introduced for explicit mentions of colour. Only objects/actions/details that were actually 'seen' in the dream were coded: for example 'I went into the round room' was coded, but 'I thought about going into the round room' was not. When repetitions were encountered, the word was coded only once if there was good ground

to believe that the repetition is a result of the writing style. Groups of objects with unknown numbers (a flock of geese, bunch of trees) were all coded as a single object. When the exact number of items was mentioned (3 ghosts) they were coded as separate objects). Table 9 shows examples of different categories as well as repetition and thought coding.

Table 10: Examples of dream coding.

Category	Coded	Not coded
Objects	Car, door, mouse, corner, sky	
Actions	Walking, pointing, falling	Talking, hanging out with, thinking
Visual action	See, notice, look at	
Spatial detail	Behind, (fall) through, between, (jump) at	
Visual detail	Dark, beautiful, round, big, fast	Soft, tasty
Colour	Red, grey, colourful	
Repetitions	T*he* ***dog*** *was sitting on the couch. I looked away to find my friend, and when I looked back up the* ***dog*** *was still there.*	*The* ***dog*** *was sitting on the couch. I approached the dog.*
	'Dog' coded twice	'Dog' coded only once
Thinking vs. doing	*I went into the basement to fetch some oranges*	*I thought about going to the basement to fetch some oranges*

Two examples of fully coded dreams are included in the appendix 9. Reliability of this coding scheme was verified by having an unpaid assistant code randomly selected dreams independently of the researcher and then comparing the results. The correlations between the ratings for each of the variables were above .980 and there were no significant differences in ratings for each category when within group t-tests were calculated for each variable.

6.4.3 Results

6.4.3.1 Dream descriptives

The mean time between the dream being recalled for the first time and the dream report was 20 days, with the maximum being a year. Overall, 10% of dreams provided were dreamt on the same day, over 56% of the dreams happened in the last 3 days, and 75% were experienced during the week before testing. The dreams were between 52 and 334 words long (mean 140, SD=55), and when irrelevant text was removed (such as comments on the dreamer's mental state after awakening), the average dream length was 125 words (SD=55, range between 30 and 329 words

There were two significant sex differences in visual dream content. Firstly, women provided more visual details in their dream report: 1.6 visual details as compared to only 0.7 such details in men's reports ($t_{(79)}$=2.66, p=.010). Secondly, there was a similar difference in the amount of colour details, with women reporting 0.5 such elements per dream and men reporting only 0.2 colours ($t_{(79)}$=2.18, p=.033). It is possible that more differences could be discovered if there were more males in the group.

6.4.3.2 Dream colour and media access

67.9% of participants reported having dreams only in colour, and 28.4% indicated that they experience both coloured and greyscale dreams. No one reported having dreams only in black and white and 3.7% of participants did not know what colour qualities their dreams have. The average age of first frequent access to black and white media was 6 years (SD=4.6), with 14% of participants indicating they never had frequent contact with black and white TV or movies. The average age of first frequent access to coloured media was 3.1 years (SD=2.7). For 90% of respondents, black and white material was less than 20% of all the media they

were watching (with majority indication they never watch anything in black and white), and for the remaining 10% is was between 20 and 40% of their media contact. When the participants who reported having only coloured dreams were compared with the participants who reported having both coloured and greyscale/mixed dreams, there were no significant differences in terms of age, or the time of access to either coloured or black and white media.

6.4.3.3 Imagery preferences and dream colour

Independent t-tests were carried out to compare people who reported having only coloured dreams with people who claimed to dream both in colour and in greyscale. A nearly significant difference in Spatial Imagery score from the OSIQ was found – people who reported dreaming only in colour scored a mean of 2.5 while people who indicated having dreams in colour and greyscale scored 2.7 ($t_{(76)}$=-1.81, p=.074).

Because a nearly significant sex difference in object imagery was found ($t_{(79)}$=1.830, p=.071) along with a significant difference in spatial imagery ($t_{(79)}$=-2.534, p=.013), a chi-square test was carried out to see if the difference in spatial imagery could not be attributed to a different proportion of males and females in the coloured and mixed dreaming groups. No significant differences between the proportions of males and females reporting different types of dreaming were found ($c^2_{(1, N = 78)}$ = 0.122, p = .485), which means that most probably the spatial imagery difference between people who report only coloured dreaming and people who also experience mixed/greyscale dreams is not caused by the sex differences in OSIQ scores.

6.4.3.4 Dream colour and dream visual content

When dream content across the two dream colour groups was investigated, there was a significant difference in the number of content words ($t_{(76)}$=-2.36, p=.021), as well as in the number of visual details ($t_{(76)}$=-2.61, p=.011), and a nearly significant difference in the number of visible actions ($t_{(76)}$=-1.95, p=.055) and spatial details($t_{(76)}$=-1.80, p=.076). Table 10 demonstrates the group means for these variables.

Table 11: Differences in dream visual content

	Colour dreamers	Mixed dreamers
Content words	115 (SD=47)	147 (SD=67)
Visual details	1.01 (SD=1.41)	2.04 (SD=1.94)
Visible actions	3.84 (SD=3.33)	5.65 (SD=4.64)
Spatial details	2.13 (SD=2.49)	3.30 (SD=2.96)

6.4.3.5 Imagery preferences and dream visual content

Pearson's correlation coefficients were calculated for OSIQ scores and the visual categories. There was a nearly significant negative correlation between Spatial Imagery score and the number of colour terms (r=-.217, p=.052), no other relationships were significant. Because the analysis did not yield the expected results, the dreams were split into two lots according to time since recall – dreams from the last 3 days (n=44), and older dreams (n=35). The reason was that perhaps older dreams would not display the hypothesised relationships because of memory interference and possible revisions to the original dream content. Surprisingly, while there were no significant correlations in the recent dreams set, there was a set of significant correlations in the older dreams. The correlations that emerged were between Spatial Imagery score and the number of colour terms (r=-.335, p=.049) as well as Spatial

Imagery and spatial details (r=.405, p=.016), there was also a nearly significant correlation of spatial imagery with visible actions (r=.316, p=.064). There was also an unexpected nearly significant positive correlation between the Spatial Imagery score and the number of visible objects in the dream (r=.325, p=.057). When data was analysed separately for males and females (due to the previously mentioned sex differences in OSIQ scores), the correlation pattern remained the same for females. In the male group, there were only 7 cases left, which precluded any meaningful analysis. A chi-square test did not detect any sex differences in the recency of dreams provided ($c^2_{(1,\ N\ =\ 79)}$=0.564, p=.315), so the visual content – imagery preference correlations that have emerged are again most probably a genuine finding, and not the result of sex differences.

6.4.4. Conclusions

This short study was the first one to investigate the possible links between imagery style and dream content. It was hypothesised that the individual's visual imagery style will impact their dream reports, so that people with higher object imagery will include more visual details into their reports, and the dreams of spatial imagers will have more spatial details and visible actions in them. The results that were obtained were partly unexpected, but provided a fascinating insight into how imagery preferences have an impact on how dreams are recalled. The main finding was that the predicted relationships between dream content and imagery did not appear in the general dream sample, but were quite evident when dreams older than 3 days were analysed. In this older dream sample, the dreamer's object imagery score was positively correlated with the number of colour terms used in the report, and spatial imagery score was positively correlated with the number of spatial details provided in the report. Firstly, the presence of those relationships is an evidence for an effect of visual imagery styles on dream

visual content. If these results can be replicated on a different or larger sample, it would open up exciting new opportunities for research on dream content. Until now, the only links between dream content and cognitive or personality styles were established for general dream features such as openness and dream bizarreness (Tartz, Baker and Krippner, 2006-7).

The second major discovery was that those relationships were only present in older dreams. This effect can be interpreted as evidence for imagery preferences working much further down the line between dream experience and dream recall than it was initially expected. It seems that imagery style exercises its influence during the time between the dream is experienced (and recalled for the first time) and the time it is written down, and the longer that time is, the more evident that influence is. This finding is in line with the general knowledge about memory as a reconstructive process and it is the first piece of evidence that suggests that cognitive style (and not just suggestions) can have an impact on how material is reconstructed. Before conclusions about the influence of imagery styles on dream recall are drawn, it is important to remember that the newer dreams might also show some of these relationships, only the current study was not sensitive enough to pick them up.

From a methodological standpoint, the difference in the correlation pattern observed between the fresher and older dreams is very crucial. The widespread acceptance of the Most Recent Dream method has been partly because the dreams gathered with it have been found to be very similar to those collected in a a sleep laboratory. If the present finding is confirmed, researchers might need to reconsider using the MRD method when they are interested in examining the more subtle aspects of dream content, or at least control for dream recency.

Finally, this study provided some further support for the idea that imagery abilities are linked with the reported dream colour, although the type of questionnaire that was used for this study precluded a detailed analysis. In this study, young people who reported having only

coloured dreams had a lower spatial imagery score than people who said they experience both types of dreaming – colour and greyscale. This finding is consistent with what was discovered in the third study in the older age sample and confirms that the tendency for focusing on spatial imagery is accompanied by more greyscale dreaming, while good object imagery is linked with more coloured dreams.

One unexpected finding was that people who reported having both colour and greyscale dreams provided dream reports that were longer and had more visual details than those who claimed to only experience colour dreams. It runs counter to the suggestion (stemming from the immutable dreams theory) that people who report greyscale dreams should have poorer memory for dream details. Because the dream reports provided were not assessed for colour properties, this relationship might be superficial. However, it is possible that the people who said they experience greyscale dreams actually had better dream memory or at least paid more attention to their dreams. Currently, there is a strong cultural bias towards colour dreaming (as discussed in chapter 3) and it is likely that people who do not usually pay attention to dreams (and thus provided shorter dream reports) might judge that all of their dream experience as coloured because that is the default. Conversely, people who track their dreams a bit more carefully might be more sensitive to the different colour patterns of their dreams and thus label themselves as mixed dreamers. A better look at the relationship between attitude to dreams and the tendency to report coloured or greyscale dreams would be necessary to see if this is the case. Figure 15 on page 127 illustrates the main findings of this study.

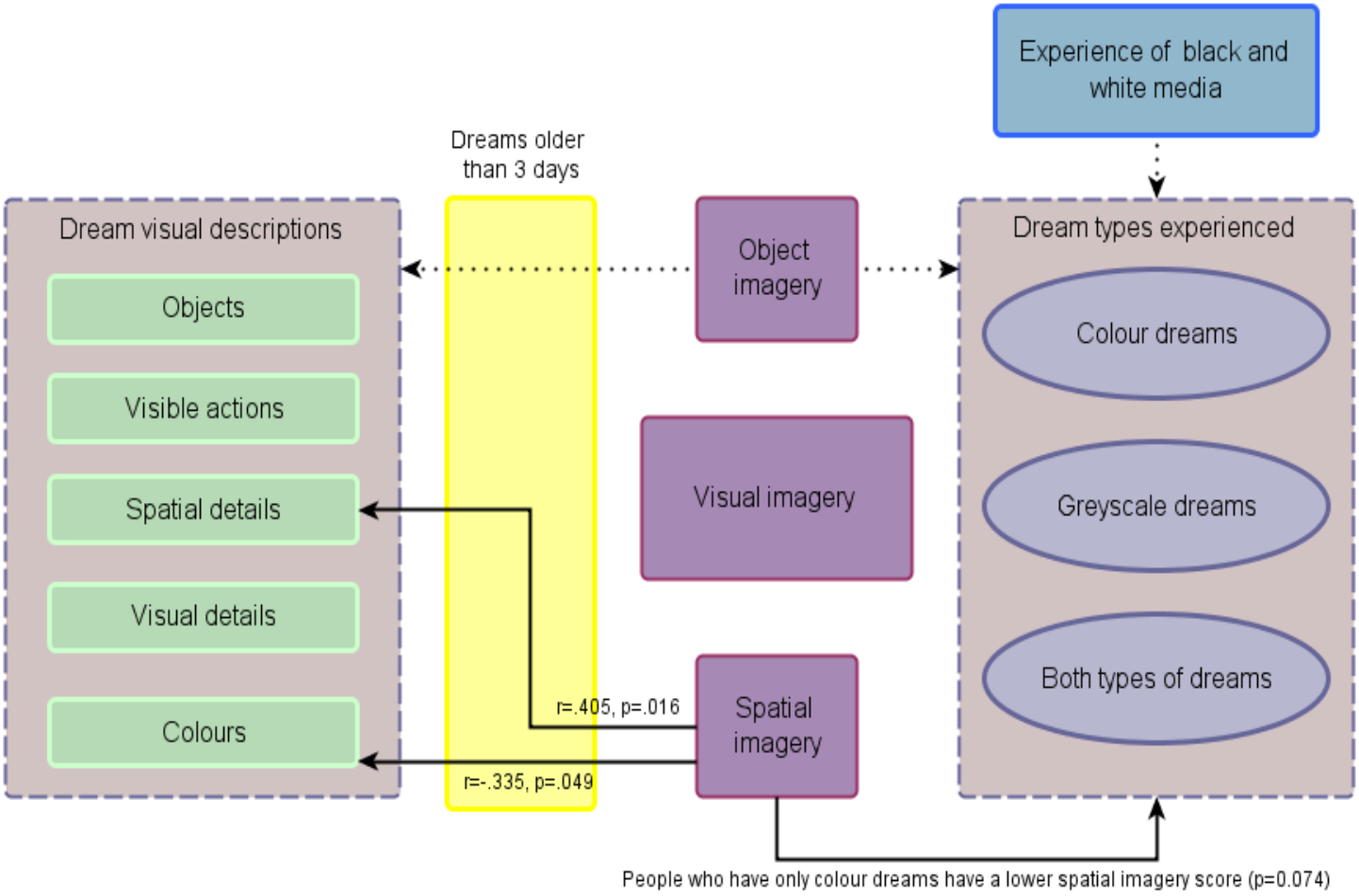


Figure 15: Overview of the main findings of study 4

6.5 Experiment 5: Visual imagery and dream content in a sample of diary dreams

6.5.1 Study objectives and hypotheses.

One of the most unexpected results that appeared in the preceding study was that the relationships between dream visual content and imagery styles was only evident in dreams that were older than 3 days. This dream recency effect, coupled with the promising effects of imagery on dream content made further investigation of dream visual content an important point of this thesis. As the previous study had used the Most Recent Dream method of obtaining dream reports, it was decided that for the present investigation a series of dreams gathered through a dream journal will be used. This was done in order to see whether the averaged properties of more than a single fresh dream might be better related to visual imagery preferences, since the current evidence supports the idea that the correlation between imagery and dream content is a result of memory shaping rather than genuine dream form differences. Because this was meant to be a short 'proof of concept' study, REM awakenings and 'on purpose' dream journals were deemed to be too time and resource consuming, leaving personal dream journals as the best way of gathering dream reports. The most available sources of personal dream journals are currently on the internet, in the form of numerous websites dedicated to recording and sharing dream experiences. Two such websites were selected basing on the possibility of contacting the dreamers in order to obtain further data. Both of the websites have been active for a few years; have gathered between a few hundred to over a thousand users and allow users to operate under pseudonyms.

The main aim of this study was to establish whether the correlations between visual imagery styles and dream visual content can also be detected in a sample of dream diary

dreams. Because the previous study only found significant correlations between imagery style and dream content for dreams older than thee days, it was hypothesised that diary dreams will not show the relationship between OSIQ variables and visual dream content. It was hypothesised that there would be a positive correlation between object imagery score and the number of visual details and colours in the dream reports. It was also hypothesised that there would be a positive correlation between spatial imagery score and the number of spatial details and visible actions in the dream report.

Finally, this study was used to gain some further support for the previous findings regarding dream colour and imagery preferences. Once again, the Object Spatial Imagery Questionnaire was used, and it was hypothesised that high object imagery score will be correlated with more coloured dreaming and a high spatial imagery score will in turn be correlated with more greyscale and mixed dreaming.

6.5.2 Method

6.5.2.1 Design

The study was based around a correlational design. The variables investigated were object and spatial imagery scores, experience with black and white media, the frequency of colour and greyscale dreaming and the number of visuo-spatial descriptions in the dream reports.

6.5.2.2 Participants

The participants were recruited from 2 websites dedicated to recording and sharing dreams: DreamJournal (www.dreamjournal.net) and Sawlogs (www.sawlogs.org.). 220 people who had more than 30 dreams in their dream logs were contacted through comments section in their dream journals or through the email address they provided publicly on their profile. 37

people responded to the initial advertisement and 23 people sent back completed questionnaires. There were 12 men and 11 women in the group and participants were aged between 19 and 51 years (mean=30 years, SD=9.3 years). All the diaries were kept in English; English was the native language for 21 of the participants, and the remaining two were German and Swedish.

6.5.2.3 Materials

The questionnaire used for this study was the same one as was employed in study number 2 and 3 (version 2.0 which can be found in Appendix 10). This questionnaire included a series of questions about the participants experience with colour and black and white media, as well as detailed questions about the colour of their dreams: whether they experience coloured, greyscale or mixed dreams, how certain they are of their judgements, what percentage of their dreams is coloured/greyscale or mixed and finally, whether they can remember an example dream from these categories. Finally, because the participants had already collected their dream reports without the experimenter's control, a question that probed how quickly after awakening they wrote down their dream reports was added.

6.5.2.4 Procedure and coding

The online respondents who did agree to participate in the study were sent 2 questionnaires through email – the Object Spatial Imagery Questionnaire and the Dream Colour Questionnaire. When they returned the two completed instruments, 10 dreams were collected from the online dream journals. Only dream reports longer than 50 words were taken for analysis. The dream reports were then prepared for coding by removing any comments

extraneous to the dream content, such as remarks about waking situation or comments about the mood or events after awakening.

The dream reports were coded for the presence of the following categories: visible objects and locations, visible actions, verbs that indicated the dreamer was seeing objects or events, spatial details and visual details, including explicitly mentioned colours. The coding scheme was identical to the one used in study 4 which is where it is described in more detail.

6.5.3 Results

6.5.3.1 Participant descriptives

The participants who had completed all the questionnaires had between 1910 and 57 dreams recorded in their online diaries (average number of dreams = 425, SD=577). Ten of their most recent dreams longer than 50 words were collected for the study purposes.

All of the participants indicated that they usually recorded their dreams within the same day of experiencing them – 30% of the group wrote down their dreams within a few minutes of awakening, another 38% wrote them down within 3 hours and the last 30% recorded them between 4 and 12 hours of waking up. Unfortunately, because the dreams were recorded independently of this study, it was impossible to recover any information about how soon each particular dream was recorded.

Only 3 participants had gained access to black and white media before gaining access to coloured movies or TV. Therefore, it was impossible to use the media experience variable in the analysis. All but one participants claimed to experience coloured dreaming (average percentage of coloured dreams = 90%, average certainty = 6.58), 8 participants said they have black and white dreams (average percentage = 15%, average certainty = 5.54) and finally, 7 participants reported having mixed dreams (mean percentage = 5%, average certainty = 5.33)

6.5.3.2 Dream descriptives

The average word count for the analysed dreams was 292 words (SD = 93.1). The average proportion of visuo-spatial descriptions in any dream report was 13% (SD = 2.98). The most frequent categories were Visible Objects (3.95%), Visible Actions (3.45%) and Spatial Details (2.78%), Visual Details comprised only, on average, 1.44% of the dream report, and colour details were only 0.35%. The most frequently mentioned colour group is the black and white spectrum (consisting of black, white, grey and silver shades), with a mean of 0.35 mentions per dream. The second colour group is the orange-red-pink spectrum, with 0.28 appearances per dream report. Finally, the purple-blue-green group was mentioned 0.19 times per a dream report. Red was the single colour most often mentioned in dream reports (19 times over 230 dream reports), with white and black being close behind with 17 and 16 total appearances.

6.5.3.3 Visual imagery preferences and dream content

The first relationship investigated was that between waking visual imagery style and visual descriptions in the dreams. There were no significant correlations between any of the visual imagery measures and Object or Spatial imagery scores. Table 11 on page 133 presents the obtained correlation coefficients.

Table 12: Correlations for imagery preferences and dream visual content

	Word count	Objects	Actions	Spatial details	Visual details	Colours
Object imagery	r=.045 p=.838	r=.243 p=.265	r=.108 p=.623	r=-.012 p=.956	r=.035 p=.452	r=.064 p=.773
Spatial imagery	r=-.344 p=.108	r=-.128 p=.405	r=-.197 p=.369	r=-.136 p=.537	r=-.203 p=.354	r=-.159 p=.469

One of the items in the questionnaire asked the dreamers to estimate how often they had problems with remembering the presence (or absence) of colours in their dreams, on a scale from 1 (never happens) to 7 (almost always). Therefore, the lower the score, the better the person's self-assessed memory for colour. When Spearman's correlations coefficients were calculated for the data, this measure was found to be nearly significantly negatively correlated with object imagery score (r=-.385, p=.091) and also had highly significant negative correlations with the raw numbers of objects (r=-.461, p=.027), spatial expressions (r=-.434, p=.039), visual details (r=-.450, p=.031) and colour terms (r=-.620, p=.002). The self-rated colour recall was not correlated with these variables when they were converted into percentage per 100 words, and was negatively correlated with word count (r=-.423, p=.044).

6.5.3.4 Visual imagery preferences and dream colour

When the correlations between the two visual imagery variables and dream colour were computed, no significant relationships emerged. Table 12 on page 134 shows the received correlation coefficients. Once again, the small sample size precluded the use of confidence ratings as a filter variable.

Table 13: Correlations for imagery preferences and dream colour

	Percentage of coloured dreaming	Percentage of greyscale dreaming	Percentage of mixed dreaming
Object imagery score	r=-.037 p=.864	r=-.214 p=.316	r=.324 p=.123
Spatial imagery score	r=-.070 p=.744	r=-.106 p=.622	r=.202 p=.343

6.5.4 Conclusions

The main aim of the present study was to investigate the relationship between visual imagery preferences and dream visual content in a sample of personal journal dreams, and demonstrate the feasibility and practicality of using online personal dream journals for research purposes. The investigation into imagery and dream content did not yield any conclusive results, as no significant relationships between visual imagery factors and dream visual content were found. This lack of effects was not unexpected – in the previous study it was found that the relationship between imagery and dream content is more pronounced in older dreams, and the present study was focusing on morning dream recall. Therefore, it is possible that the recency of the dreams analysed here precluded any effects from appearing. If this is indeed the case, the previous findings regarding the correlation between visual imagery preferences and visual dream details might indeed be a result of a reconstruction of the dream narrative to fit the cognitive style of the dreamer. However, because only a very small percentage of dreamers agreed to participate in this research, the final sample size ended up being somewhat small – introducing the possibility that the lack of results is an effect of insufficient power. The previous study found results in a sample of 81 dreams and in a selected sample of 35 dreams – this study had only 23 participants, and even though each

contributed 10 dream reports, this only reduced the chance variability of dream properties. Therefore, it is impossible to judge whether the lack of results is the expected effect of the dream recency, or whether it is a result of small sample size. The inquiry into overall dream colour and imagery variables also did not yield any results. Once again, it is most probably due to the small sample size.

One interesting finding was the very high correlation between the number of visual details in dreams and the self-rated tendency to recall visual dream details. These correlations were as high as or even higher than any of the previously recorded correlations of imagery preferences and dream detail. Perhaps unsurprisingly, people who are keeping a long term dream journal can reasonably accurately assess their dreaming experiences. It would be interesting to see if people who are not as interested in dreaming are also as reliable when they are asked to rate how good they are at recalling particular elements from their dreams.

6.6 Experiment 6: Dream colour in Polish adults

6.6.1 Study objectives and hypotheses

The main point of the media influence hypothesis states that people who had prolonged experience with black and white media in their youth will recall more greyscale dreams than people with no such exposure. During the course of the 1st study it was found that people over 55 years of age indeed report more greyscale dreams, and this tendency was then linked to their experience with black and white media. The age group comparisons carried out in the 3rd study did not confirm these findings, mostly due to the small group sizes (and the high variability within groups), younger average age in the older group and the particular composition of the older age group that precluded the possibility of analysing the impact of black and white media separately from age. Therefore, more evidence for the influence of media on dream colour was required. This study was designed to look at how early experience with black and white media could influence dream colour, but using a completely different approach. In the UK, finding people who had spent their childhood with a black and white TV required recruiting participants over 60 years of age, making any results obtained susceptible to issues with memory and dreaming changes that happen with age. Therefore, the researcher's international background was utilised and the study was conducted in Poland. Because Poland belonged to the communist block, coloured television was a rarity until the late 1980's – even a lot of people in their late 20's remember watching black and white television in their youth. And since almost every adult has had extensive experience with black and white media, it is possible to conduct a study on a middle aged sample, thus avoiding issues with introducing possible age-related variables. The factors investigated in this study were mainly media experience and dream colour, but visual imagery style and

dream visual content were also included to provide a wider view of what factors affect dream colour in Polish adults. The choice of the age group was also motivated by the desire to compare the typical dream colour of Polish and UK middle age adults, whose dreaming patterns were examined in study 2. At the same time, the development of the research questions towards the impact of visual imagery on dream content prompted the inclusion of the Most Recent Dream form into the study design. Because this study would once again gather recent dreams (as did study 4), it was an opportunity to see if similar relationships between dream details and imagery style would be seen in a sample of foreign, middle aged adults.

The main hypothesis of this study was that the length and first age of access to black and white media would be correlated with the frequency of greyscale dreaming. Because this study used the last recalled dream paradigm, it was also hypothesised that there would be correlations between spatial imagery and the amount of action and spatial phrases, and a correlation between object imagery and the number of visual details and colour terms in the dream reports. Finally, the last hypothesis stated that there would be a relationship between visual imagery scales (object and spatial scores) and the colour of dreams.

6.6.2 Method

6.6.2.1 Design

The study followed a correlational design. The main variables investigated were the reported colour of dreams, visual imagery preferences and the amount of visual features in the dream report. Additionally, experience with black and white media was recorded.

6.6.2.2 Participants

The participants were recruited from the teachers at a large high school in Katowice, Poland. 5 males and 19 females volunteered to do the study. The average age of the participants was 44.5 years (SD=10 years).

6.6.2.3 Instruments

Three instruments were used for this study: the OSIQ questionnaire (Appendix 11), the dream colour questionnaire v.2.1 (which can be seen in Appendix 12) and the most recent dream form (Appendix 13). The dream colour questionnaire was modified to see if providing participants with an ordinal rating scale for dream frequency would make it easier for them to assess their dream colour. All of these instruments have been used in earlier studies, where they are discussed in detail. Translation into Polish was carried out through the commonly used procedure of double-blind translation. First, the researcher translated the instruments into Polish and then handed them over to a native Polish speaker with a psychology degree at a UK university for back translation to English. The second translator did not previously see the English versions of those instruments. When the translation was complete, the original and double-translated versions were compared and any inconsistencies were corrected in the Polish translation. This procedure was then repeated with a different translator and the two resulting Polish versions were nearly identical. Additionally, the translated instruments were presented to a small control group similar in age and demographic status to the target group of teachers, who checked them for clarity and understandable language.

6.6.2.4 Procedure

The teachers were told about the study during one of the teacher meetings at their school. Those who wanted to participate received the questionnaires and the last recalled dream form

and filled these in after the meeting in a group setting. The instruments took 25 minutes to administer.

6.6.3 Results

6.6.3.1 Group characteristics

The average age at which the participants gained access to black and white movies was 7.6 years (SD=3.7 years) and the average age of regular access to black and white television was 8.2 years (SD=6 years). These values were higher in the case of colour media: the average age of regular access was 13.5 years (SD=4.5 years) for colour movies, and 17.2 years (SD=10.2 years) for coloured television. Only three people had gained access to colour media at the same time as to black and white media. These figures reflect the typical socio-economical situation in Poland, as coloured television was a rarity before 1980's.

21 participants out of the group of 24 claimed to experience coloured dreaming, 17 participants said they had black and white dreams, and 15 participants also reported having dreams that were a mix of colour and greyscale. The average certainty for coloured dreams reported was 4.62 (SD=2.47), the certainty for greyscale dreams was reported as 5.20 (SD=2.21) and the certainty for the experience of mixed dreams was 4.52 (SD=2.56). Figure 16 on page 140 shows the frequency estimates of each type of dreams.

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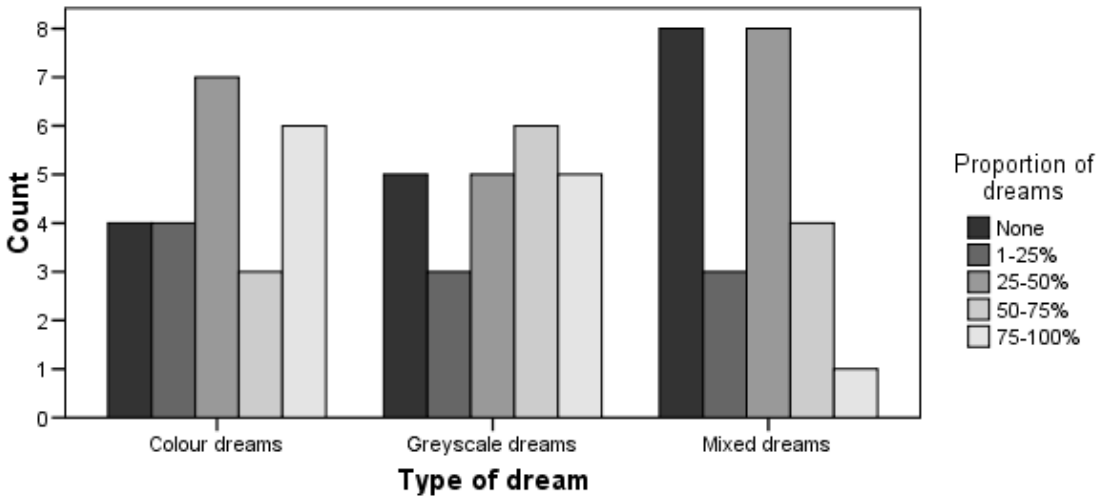


Figure 16: Frequency of various colour types of dreaming in a Polish adult population

6.6.3.2 Media access and dream colour

In this group, majority of participants had gained access to black and white media before gaining such access to coloured media, therefore age of access to coloured media and length of sole access to black and white media were used as the main independent variables. The participants' age was strongly correlated with the age of colour media access and almost significantly positively correlated with the time spent with black and white media. While this correlation is entirely expected due to the natural relationship between the participants' age and the popularity of colour media, it has the potential to undermine the strength of any potential media relationships. On the other hand, the average of the participants in this group precludes any strong ageing effects from influencing the data. When the relationship between media access and dream colour was investigated, a nearly significant correlation was found: age of colour television access was negatively correlated with the percentage of coloured dreaming ($r=-.423$, $p=.063$). The length of black and white media access was not related to any of the dream colour measures. When between group comparisons were made, with the

experience of greyscale and mixed dreams as grouping variables, there was a single nearly significant group difference. On average, the people who did report black and white dreams gained access to coloured TV 8 years later (at the age of 19.5) than those who did not report such dreams ($t_{(22)}$=-1.834, p=.080).

6.6.3.3 Imagery and dream colour

Surprisingly, there were no significant correlations between the two visual imagery variables and the frequencies of either coloured or greyscale dreaming. The small sample size precluded the use of confidence ratings as a selection variable. Table 13 presents the correlation values for the whole sample.

Table 14: Correlations for imagery preferences and dream colour

	Percentage of coloured dreaming	Percentage of greyscale dreaming	Percentage of mixed dreaming
Object imagery score	r=.280 p=.232	r=.034 p=.893	r=-.255 p=.359
Spatial imagery score	r=-.086 p=.718	r=.083 p=.744	r=.037 p=.895

6.6.3.4 Imagery and visual dream content

The mean word count for the dreams provided by this group was 73.24 words (SD=42.09), which was lower than the report length provided by the young group examined in study 5. When the correlations between visual imagery styles and dream visual content were investigated, two hypothesised correlations were found. The first one was a nearly

significant correlation between object imagery score and the number of visual details in the dream report (r=.386, p=.084) and the second one was a significant negative correlation between spatial imagery score and the number of colours mentioned (r=-.597, p=.004). There was no correlation between spatial and object imagery scores.

6.6.4 Conclusions

The most important finding of this study was the high amount of greyscale and mixed dreams that were reported in the studied sample. The structure of the dream colour experiences in the group is very similar to the one seen in the 1st study in the older group, even though the group average age is 20 years less than of the adults in the first study. It can be argued that the introduction of the ordinal questionnaire measurement scale could have artificially inflated the rates of greyscale dreaming more than the use of the older versions of this instrument. The second study, which used the original questionnaire style on UK middle aged adults did find lower rates of greyscale dreaming, but the British population also had lower levels of black and white media access. Thus, it is difficult to say whether the higher rates of greyscale dreams reported in the Polish population are an artefact of the new method, or are indeed a reflection of the actual dreaming patterns. A diary study that would compare the ratings from different types of questionnaires with journal dream assessment would be necessary to explore this issue fully. The second important finding is the strong link between the age at which people gained access to coloured media and the frequency and experience of colour dreaming. While the timing of access to colour media was strongly influenced by the age of the participants (which is quite expected, as the access to colour television was dictated by state economy) it seems unlikely that age is the driving force behind this association since the group examined is relatively young. When the influence of ageing on dreams and memory

was discussed in the introductory chapters, it was pointed out that the age related changes that could account for greyscale dreaming do not appear until the person reaches their late 60 and 70's. Therefore, it seems highly probable that the ageing processes cannot be the explaining force behind the frequent greyscale dreams experienced by the Polish population.

The only place where age influence might be seen is the dream report length. This disparity could be caused by the age difference – as it was discussed in the introduction, dream recall frequency sharply drops at the age of around 25-30 years. This drop is most probably caused by a change of life circumstances that prevent people from leisurely paying attention to their dreams every morning. However, in this particular study the lower dream report word count might also be a consequence of the structure of the Polish language which uses fewer words to express the same meaning. Polish necessitates fewer or even no articles and the conjugation based grammar allows to express relationships without having to resort to indicators of directionality. So, a 6 word sentence 'John gave a book to Jane' becomes a 4 word sentence in Polish: 'John dał Jane książkę'.

A less expected finding was that of an apparent lack of relationship between the OSIQ scores and reported dream colour. While it is difficult to talk about negative results in such a small sample with any confidence, it is likely that in a population that has a good reason to experience greyscale dreams (namely, influence of black and white media) the slight impact of visual imagery styles is masked by the more powerful differences caused by media. It is nonetheless possible that visual imagery could be a factor when a larger group would be examined with more sensitive instruments.

Despite the lack of a detectable relationship between imagery preferences and dream colour, the visual contents of the Polish adults were related to their imagery style. Even though the sample was too small to filter out dreams based on confidence ratings or time of

recall, there were some significant and expected correlations that once again bolster the hypothesis that the type of waking imagery has an impact on how dreams are remembered and recalled (and perhaps, even experienced). The fact that these relationships were apparent in a completely different age sample and in dreams written up in a different language speaks in favour of the hypothesis that personal imagery preferences reflect in how dreams are described. Figure 17 presents the main findings from this study.

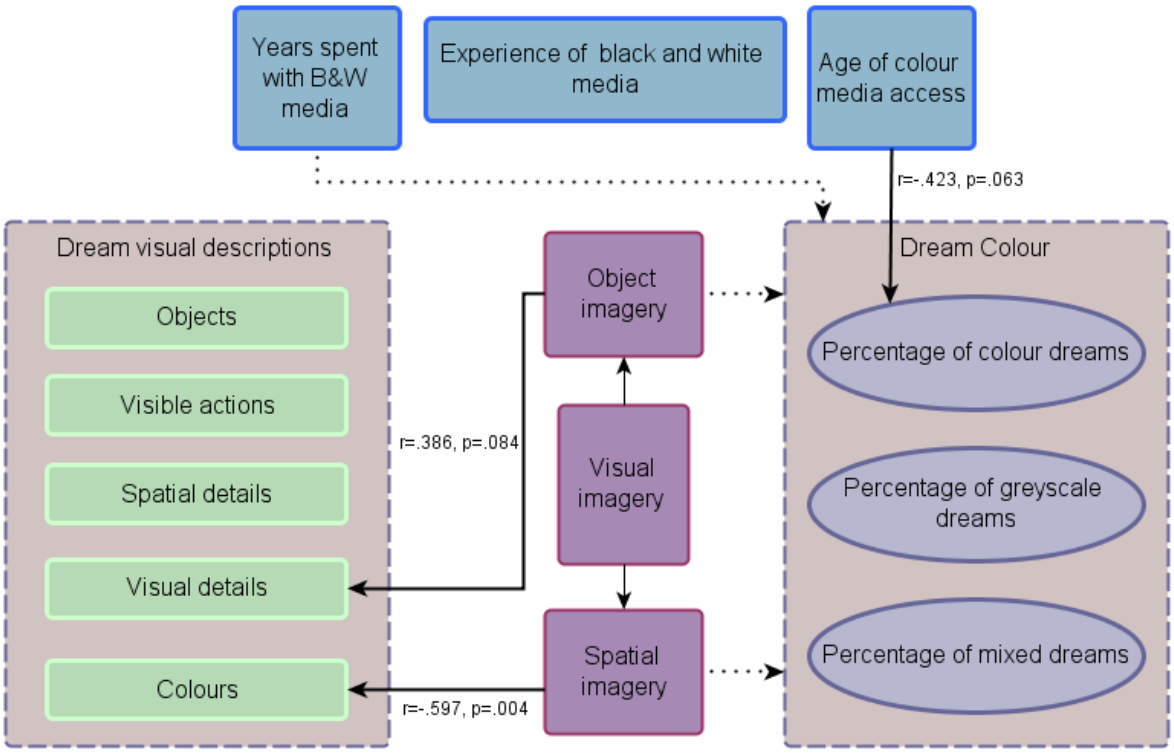


Figure 17: Overview of the main findings of study 6

6.7 Experiment 7: Imagery, memory and dream colour.

6.7.1 Study objectives and hypotheses.

As the last piece of research in this series, the main aim of this study was to replicate the findings of the previous studies, with a focus on the relationship between the colour of dreams and visual imagery and colour memory. The previous studies have suggested that visual imagery preferences are a factor in the visual features of colour: the preferences have been shown to correlate with questionnaire assessment of dream colour (Study 3 and 4), and have been implicated in the number of visual elements present in the dream report (Studies 4 and 6). Colour memory was not confirmed as a significant factor in the third study, but at the same time there were some hints that it might play a role in the reported dream colour. However, a lot of this findings were inconsistent, and a lot of the conclusions could not be drawn due to doubts about the questionnaire reliability. Because of this, a decision was made to re-evaluate the contribution of imagery and memory preferences using a dream diary approach and supplementing OSIQ with two additional object recognition tasks that Kozhevnikov, Kosslyn and Shephard (2005) found to be correlated with Object Imagery. The additional tests were introduced partly as a study design element, since they make for good distraction tasks to give between material presentation and recall, and partly to provide a task-based assessment of object imagery, as opposed to the self-assessment nature of OSIQ. Incidental colour memory was investigated as another way of measuring object imagery (since memory for visual details is included in the concept) and as a factor in itself – the ability to tell whether an image was seen in colour or black and white should be important for the reporting of dream colour.

The novel element of this study was the task in which the participants would write a description of a video clip they had seen. This task was introduced with the aim of investigating whether visual memory and imagery preferences can also have an impact on the reporting of a uniform visual 'stimulus' and whether there are any similarities in the visual description style between dreams and waking reports. Comparing the video description, dream diary reports and last recalled dream reports (taken from the previous studies) can provide some insights into where in the route between the dream experience and the dream report visual imagery preferences shape the dream content.

The methodological factors were also revisited. In the first study, no differences between a diary and questionnaire measure of dream colour were found – however the instruments used were quite simple, and no other study was carried out to retest that finding. Therefore, this study set out to once again compare people's diary and questionnaire reports of dream colour. Time between awakening and dream recording was included as a standard way of controlling for the time of recall related distortions. The final major methodological point of this study was the use of a dream diary format where actual dream reports were gathered for analysis. This data lent itself to re-investigating the links between imagery and the dream visual content – but also provided the thesis with the last piece of a puzzle: with this study all dream report sources, with the exception of REM awakenings, have been employed, creating a unique opportunity to compare the results of the different studies across the various dream collection methods.

Because study 7 was not planned as a cohort comparison, there were no expectations regarding the appearance of media influence. Therefore the working hypothesis was that there would be no effect of age of access to colour or black and white media on the reported dream colour. Specific hypotheses regarding the remaining factors were set in more details. These

predictions can be grouped into three main categories: source comparison, visual imagery and memory influence on dream colour, and impact of waking visual imagery on dream visual content. In the first category, it was hypothesised that there would be no significant differences between the diary and questionnaire rates of reporting of coloured and greyscale dreaming. This hypothesis was put forward as a consequence of the 1st study, in which no such differences were found.

In the second set of hypotheses, the main predictions were that good object imagery would be related to higher recall of coloured dreaming and high spatial imagery would be related to higher recall of greyscale dreaming. It was hypothesised that this relationship would be present both in the questionnaire data and in the dream diary derived estimates.

Since dream content was once again analysed for the relationship between imagery styles and visual descriptives, it was hypothesised (basing on the results of the previous studies) that since the dream reports are obtained through a dream diary, there will be no detectable relationships between any of the imagery variables and the visual aspects of the dream reports.

6.7.2 Method

6.7.2.1 Design

This study followed a correlational design. The main variables investigated were visual imagery abilities (measured with a self-assessment questionnaire and 2 object recognition tasks), colour memory, colour of dreams (self-assessed in a questionnaire and sampled with a dream diary) and the visual imagery descriptions across the dream reports and video clip descriptions. Some between group comparisons for sex differences were used, along with

within group comparisons that tracked the similarities between the dream diary and questionnaire reports.

6.7.2.2 Participants

The participants were recruited through University of Dundee weekly advertisement system from the pool of year 1 and 2 psychology students, and were offered 3 course credits and a chocolate bar for their involvement. As in the previous studies, the student has a wide array of course credit studies to choose from. 59 University of Dundee students volunteered for this study and 55 completed the study. There were 15 males and 40 females in this group, and the average age was 20.9 (SD=4.34).

6.7.2.3 Materials

Visual Imagery

Three instruments were used to assess visual imagery. The Object Spatial Imagery Questionnaire (discussed in more detail in Experiment 3 and available in Appendix 7) was supplemented with two task measures that were previously found to be related to the Object Imagery factor (Kozhevnikov, Kosslyn and Shephard, 2005), and were taken from the Kit of Factor Referenced Cognitive Tests (Ekstrom, French, Harman and Dermen, 1976). The Gestalt Completion Test (Appendix 14) involves identifying 20 images of objects that had parts removed, and takes 4 minutes to complete. The Snowy Pictures Test (Appendix 15) is a series of 24 images that have been visually degraded through adding random noise to make them more difficult to recognise, and it takes 6 minutes to complete. The additional tests were included to provide an assessment of visual imagery ability independent of self-rating.

Colour memory

Incidental memory for colours was tested with a delayed recall slideshow of coloured and black and white photographs. 23 digital photographs, showing concrete objects, scenes or people, were chosen from the photograph set used in study 3, with the ease of naming as most important criterion. 12 of these photographs were in colour and 11 were in greyscale. The photographs were similarly sized and were randomised across the slideshow. Each photograph appeared on the screen for 3 seconds. The participants recorded their answers in an answer sheet that contained a list of all images, with names that were established to be most common labels for the photographs .

Dream colour

Dream colour and dream report visual qualities were assessed through a questionnaire and a dream diary. The questionnaire used was the 'dream colour questionnaire' designed and fully explained in study 2 (available in Appendix 4) It asks for personal experience with coloured and black and white media, as well as asks for ratings of frequency of the three types of dreams: coloured, black and white and mixed.

A dream diary (Appendix 16) was provided for the participants to keep for 7 days or until they gathered 10 dreams, depending on which happened first. The participants were asked to first write down the content of their dream and then to answer a few specific questions regarding the colours remembered from the dream. This section inquired into the specific colour recalled, whether the participants were sure if the whole dream was in colour and the presence of any unusual greyscale elements. The colour question structure was loosely based on the items from the dream diary used in the first study.

Clip description

A 2 minute 47 second video clip taken from the movie ‘The Science of Sleep’ was used as the video stimulus. The clip presented a scene in which the main character has an unusual dream (the online version of the video clip can be accessed at http://www.youtube.com/watch?v=paHSFXQfL5E). The recall sheet (Appendix 17) had the same type of instructions that are used in gathering dream reports that were slightly modified to refer to the features of the video clip rather than viewer’s private experience.

6.7.2.4 Procedure

After signing the informed consent form, the participants started with watching the photograph slideshow that was presented on the computer screen. They were asked to name each of the pictures as they appeared for 3 seconds each. The participants were told this would be a part of a general memory test, and that they should focus on identifying and naming the pictures. This was done to make sure that each picture was attended to, and at the same time the participants would not purposefully focus on the colour aspects of the photographs. When the slideshow finished, the participants were presented with the Gestalt Completion Test and were given 4 minutes to complete it. If they finished identifying all the images in less than 4 minutes, they were kept busy by the experimenter until the allocated time had elapsed. On occasion, the participants who were non-native English speakers were instructed to write down the names of the objects in their native language, if they didn’t know the English equivalent. If the time limit permitted, the translation was carried out immediately, if not, it was postponed until after the recall task. After this, they were handed the slideshow picture list and were asked to recall which pictures were shown in colour, and which were shown in greyscale, and if they recalled colour, name a few colours they could remember most vividly from the picture. The overall time delay between the slideshow and recall was 6 minutes. The second phase of the study started with the participants viewing the video clip from Science of

Sleep. They were informed that they would be required to describe what happened in the video clip afterwards. When the clip finished, the participants were given the Snowy Pictures Test to complete in 6 minutes. Once again, if they finished identifying the images faster, they were kept occupied by the experimenter by talking about the image task. If translation was required, the procedure from the Gestalt Task was adapted. After approximately 8 minutes from watching the video clip, the participants were given a recall sheet and were asked to write down what happened in the scene they watched with as much details as they could recall. The participants were not given a time limit for this task. When they finished writing, they were given two last instruments to fill out – the Object Spatial Imagery Questionnaire and the Dream Colour Questionnaire. Finally, the participants were presented with the dream diary and given a full explanation of how they were to fill it out for how long to keep it. The participants were instructed to return the diary to the psychology reception, and to hand them in regardless of the number of dreams collected to get the course credit. The acceptability of handing in an empty diary was stressed to maximise the return rate and to ensure participants would not feel obliged to fabricate dreams in order to get course credit. The diaries were numbered, so that the returned diaries would not be identified prior to coding.

6.7.2.5 Coding

The dream diary dreams and the video clip descriptions were coded according to the rules specified in study 5. The video clips and diaries were coded in separate batches (first all the clip descriptions and then all the diaries), with the individual data sets coded in a random order. A time gap between the two coding tasks was introduced to avoid linking the two sets (by the participant numbers or handwriting style) and producing expectations while coding, since such expectations could introduce a bias into the procedure. The author was careful not

to go back to any of the other data gathered in this study while coding, again to avoid introducing expectations basing on the individual's imagery or memory results.

The coloration of the particular dreams in the dream diary was coded on the basis of the participant's responses to the questions at the end of each dream record page (similarly to study 1). When the patterns of answers was inconsistent (for example, indicating that the whole dream was in colour, but at the same time also agreeing that it was in black and white) or the answers were missing, the dream was coded as 'unclear', otherwise it was categorised as either 'colour', 'greyscale' or 'mixed'.

6.7.3 Results

6.7.3.1 Dream diary descriptives

Out of the 59 people recruited for the study, 55 returned the dream diaries, and only their data was analysed. Only one person returned an empty diary, with the majority of people providing 3 or 4 dreams. The average number of dreams in the 7 day period was 4.44 (SD=2.32). The average length of dreams was 151 words (SD=68) and the average time between waking up and completing the diary page was 57 minutes (SD=92). Overall, 64% of participants recorded their dreams within 30 minutes from awakening.

6.7.3.2 Media access descriptives

12 participants indicated they never had regular access to black and white media, and the remaining people had gained regular access to colour media before they watched black and white movies or programmes. The average age of introduction to colour media was 3.2 years (SD=2.6) and for black and white media it was 6.5 years (SD=5.1). There were no

differences between the television and movie ratings for age of access, which is again expected in a group of people who were brought up with a television in their homes.

6.7.3.3 Sex differences

Because previous studies have shown there are significant differences in the visual imagery preferences between males and females, sex differences in the imagery and memory variables were investigated. A significant sex difference was found for the Spatial Imagery scores, with females reaching an average score of 2.51 (SD=0.46) and males scoring 2.96 (SD=0.37) ($t_{(53)}$=-3.441, p<.001). There was also an almost significant difference in Object Imagery scores ($t_{(53)}$=1.801, p=.077), with females scoring somewhat higher than males (average 3.68 score, SD=0.54, vs. 3.38 score for males, SD=0.54). No sex differences for the colour memory task or for the two object recognition tasks were found.

A few sex differences were found in the dream variables. Women had a significantly higher rate of dream recall during the study period ($t_{(52)}$=2.118, p=.039) – on average they recalled 4.85 dreams in the 7 days (SD=2.44), while men recalled 3.40 dreams (SD=1.59). This finding is in line with other studies on dream recall frequency (Schredl and Piel, 2003). Additionally, one aspect of video clip description was showing a sex difference, namely word length ($t_{(53)}$=2.054, p=.045) with females writing on average 297 word reports (SD=23.4) and males writing only 236 words (SD=18.6).

No other dream diary measure (neither dream colour nor visual details) or video clip variable was found to differ across the sexes once report length was accounted for. One notable nearly-significant result, however, is the sex difference in the questionnaire frequency of black and white dreams ($t_{(53)}$=-1.902, p=.073), with men claiming that 23.3% of their dreams are in black and white (SD=25.5) as opposed to the 9.90 (SD=16.3) stated by women. Another almost

significant sex difference lies in the diary percentage of coloured dreams ($t_{(52)}$=1.688, p=.097), with 78.8% (SD=32.2) of female dreams classified as coloured, as compared with 62.2% (SD=32.7) of coloured dreams in males. Because of these sex differences, separate analyses for each sex were introduced when OSIQ correlations were calculated.

6.7.3.4 Dream diary and questionnaire comparison

When the proportions of the three dream types were compared across the dream diary and the questionnaire (using a repeated measures t-test), an interesting pattern emerged. While there were no differences in the reporting of colour of mixed dreams, there was a significant difference in the reported frequency of greyscale dreaming ($t_{(54)}$=2.831, p=.009), with people reporting more greyscale dreams in the questionnaire than in the dream diary. Table 14 shows the comparison between the results of the diary and the questionnaire.

Table 15: Diary and questionnaire proportions of three dream types

	Questionnaire	Dream diary
Proportion of coloured dreaming	78.81 % SD=23.23	74.25 % SD=33.03
Proportion of greyscale dreaming	13.81 % SD=19.99	5.23 % SD=18.78
Proportion of mixed dreaming	16.11% SD=23.31	16.63% SD=23.54

One possible explanation of the difference between the diary and questionnaire lies in the short sampling period. Majority of people contributed around 3-4 dreams, and if greyscale dreams do form around 14% of dreams, such a small sample could mean there was a high

chance of missing some greyscale dreams and thus artificially lowering the dream diary estimate. This was not an issue ion the first study, where no dream reports were asked for and people contributed more dreams. One answer to this is to check whether people who have contributed more dreams have also a higher number of recorded greyscale dreams – which is not the case. On the contrary, if there is any effect of dream recall on dream colour, the people who recall more dreams tend to recall these 'extra dreams' in colour. There is a very strong correlation between the number of dreams recorded and the number of coloured dreams, $r=.856$, $p<.001$; while there are no relationships between recall frequency and the two remaining types of dreams. It seems safe to state that the time of sampling is not a major issue, although a longer term diary study would be necessary to solve this issue completely. An alternative explanation comes from the fact that the questionnaire did not have an option to choose 'I don't know', while the diary coding permitted some dreams to be coded as unclear or impossible to identify. Thus, if we assume that there is a certain proportion of dreams that people cannot reliably identify as coloured or not, in the questionnaire they were forced to assign some type of colour to those dreams nonetheless, perhaps labelling them as greyscale. In a way, the construction of the forced choice questionnaire replicated the bias that was assumed to be the cause of greyscale dream reports in the early 20th century.

In one of the previous studies self confidence ratings for questionnaire estimates of dream colour were identified as a potential way of assessing how reliable the questionnaire estimates are. Because this study gathered data on both questionnaire and diary dream colour patterns, it became possible to see whether the difference in diary data and questionnaire estimates was related to the individual's confidence ratings. Both the relative and absolute difference values were considered, the absolute difference being a measure of general difference in estimation, and the relative difference preserving the direction of the difference.

Table 15 presents the results. The only significant relationship was found for the relative difference between diary and questionnaire frequency and confidence for coloured dreams (r=.276, p=.043). Because a negative relative difference between questionnaire and diary score indicated that a person underestimated the percentage of that dream type, while a positive score said that a person overestimated that particular dream colour type, this result means that the people who expressed higher confidence in their coloured dreaming estimates tended to overestimate the proportion of coloured dreams. It would thus seem that the self-rated certainty measure leaves something to be desired in terms of its validity. However, when interpreting this result it has to be kept in mind that the small number of dreams that was recorded in the diary might have not allowed for a completely valid representation of a person's dream colour proportions. It is possible that when a larger sample of dreams would be collected the high confidence dreamers would indeed end up with more coloured dreams as they predicted.

Table 16: Correlations between the questionnaire-diary gap and confidence ratings

	Colour dreams	Greyscale dreams	Mixed dreams
Relative difference	r=.276*	r=-.073	r=.032
	p=.043	p=.599	p=.822
Absolute difference	r=-.212	r=.212	r=-.053
	p=.124	p=.124	p=.704

6.7.3.5 Media access and measures of dream colour

As there were no participants who had gained access to black and white media before coloured media, the age of first access to colour media was used as the independent variable. Because the main hypothesised factor responsible for greyscale dreams is the actual contact with black and white media, it might seem pointless to perform any analysis here. However, there is one case in which the age of access to colour media would have an impact on dream colour, and that is if human dreams were, by default, not just in colour, and colour media helped to set them as coloured. A weaker version of this position states that while all dreams are in colour, colour media provides such a compelling schema of dreaming, that it encourages people to classify all of their dreams as coloured.

When the correlations were computed, there was an almost significant negative correlation between age of colour media access and the proportion of coloured dreams as gathered with the questionnaire ($r=-.254$, $p=.061$), but no such relationships were found for the dream diary estimates of dream colour. While the direction of the questionnaire correlation is within expectations (later access to colour media related to less coloured dreaming), its appearance is rather surprising. The fact that this relationship shows up in the questionnaire data, but not the diary results might mean that early access to coloured media has a strong impact on how dreams are recalled and categorised during waking time, but not necessarily at how they are actually experienced (since diary records are closer to the actual experience than mid-day estimates). An alternative explanation is the possibility of experimental suggestion – while the study was carried out in a way that did not inform the participants about the hypotheses, the overall topic of my research has become known across the university due to a few media publications. It is quite likely that the participants were influenced by their preconceptions of the study hypotheses, and adjusted their questionnaire answers accordingly. This effect did not

occur at the diary level presumably because it is more difficult to retouch immediate dream memories as opposed to adding or subtracting a few percent from the overall dream type proportion ratings.

6.7.3.6 OSIQ and other measures of imagery/memory

Because the two object recognitions tasks and the colour memory task were introduced as support for the OSIQ questionnaire, their correlations with the object and spatial imagery scales were computed. Surprisingly, there were no significant correlations between either the two scales and the Gestalt and Snowy pictures scores, or the colour memory score. Table 16 shows the correlations between object and spatial imagery and the remaining variables.

Table 17: Imagery preferences and task measures of memory and imagery

	Gestalt score	Snowy Pictures score	Colour memory score
Object Imagery score	r=-.058	r=-.148	r=-.109
	p=.676	p=.280	p=.430
Spatial Imagery score	r=-.123	r=.085	r=-.152
	p=.369	p=.538	p=.269

When the correlations were computed separately for both sexes, nothing significant emerged in the female group, but there was one correlation that was significant in males – Spatial Imagery score was negatively correlated with the colour memory task performance (r=-.522, p=.046). This sex difference in how visual imagery preferences and task measures of memory interact is interesting, and are addressed later.

6.7.3.7 OSIQ and questionnaire measures of dream colour

When the correlations between the visual imagery variables and questionnaire estimates of dream colour were calculated, two effects were evident: Spatial Imagery score was significantly negatively correlated with the percentage of coloured dreaming (r=-.373, p=.005) and was positively correlated with the percentage of greyscale dreaming (r=.335, p=.012). Both of these correlations are in agreement with the initial predictions of how visual imagery preferences will impact reported dream colour. Object imagery score was not found to be correlated with any dream colour type.

Separate correlations were then computed for both sexes (due to the before mentioned sex differences in OSIQ scores) and a very interesting change in the correlation patterns occurred. In the female group, Object Imagery was, again, not related to any of the questionnaire variables, while Spatial Imagery was negatively correlated with the percentage of coloured dreaming (r=-.406, p=.009). In the male group, however, Spatial Imagery was not correlated with any dream type proportion - the role of the main predictor of dream type was overtaken by Object Imagery. Object Imagery was positively correlated with the proportion of coloured dreaming (r=.593, p=.020), negatively correlated with the proportion of greyscale dreaming (r=-.529 p=.043) and almost significantly negatively correlated with percentage of mixed dreaming (r=.511, p=.052). The scatterplots of the effects of imagery style on each of the dream types in both sexes are available in Appendix 18.

Both of the correlation patterns follow the hypothesised influence patterns, but the predictive variable changes across the sexes. One explanation of this phenomenon could lie in the sex difference in how the questionnaire items within the scales are approached. Theoretically, both Object and Spatial scales should be correlated with the types of dreaming regardless of the sex of the sample. However, if females provide artificially elevated answers

to the items in the Object Imagery scale – because having a good visual detail memory is seen as an element of being a female – that scale will lose its diagnostic value. The spatial scale, however, will retain some validity – although the extent to which females might underestimate their spatial imagery abilities can still have an impact on the predictive value of that scale. Similarly, if males provide uniform answers to the Spatial Imagery items – since having good spatial imagination is seen as an element of masculinity – their actual spatial imagery preferences are obscured, and Object Imagery becomes the most valid way of assessing imagery style.

6.7.3.8 OSIQ and diary measures of dream colour

The correlations between the two imagery variables and the dream type proportions as gathered through the dream diary are quite similar to those obtained in the questionnaire: There is a significant negative correlation between spatial imagery and the percentage of colour dreaming (r=-.316, p=.020) and a nearly significant correlation between spatial imagery and the percentage of greyscale dreaming (r=.236, p=.085). Object imagery is not correlated with any of the dream type frequencies.

When the correlations were computed separately for both sexes, nothing as radical as in the previous set of correlations occurred. In the female group, Spatial imagery was still negatively correlated with the percentage of coloured dreaming (r=-.385, p=.015), and it was sub-significantly correlated with greyscale dreaming (r=.294, p=.070). In the male group, there were no significant correlations between Object and Spatial imagery measures and the dream type frequencies. Figure 18 on page 162 presents the correlation patterns for males and females for both the diary and questionnaire. This lack of effects in the male group (which stands in contrast with the very interesting correlations seen when questionnaire estimates are

used) can be seen as the result of two mechanisms. One explanation invokes the issues with the dream diary sampling and the group size: there were only 15 males in the group, and on average they contributed fewer dreams than women did. This could mean that the male dream pool was not representative enough for the correlations to come through, and that a few outliers could completely remove any visible effects. The other explanation hinges on the different nature of the diary and questionnaire estimates and proposes that males who are poor object imagers only think they experience less coloured dreams, while in fact their dream colour pattern does not differ from good object imagers. When asked to provide a global estimate of dream colour, low object imagers will underestimate the amount of coloured dreams they have, but they will record a more correct value in the dream diary. The main problems with this explanation lies in the fact that only males would do that – the correlation pattern between imagery and dream colour in females was replicated between the diary and questionnaire outcomes. Therefore, at this point the methodological explanation seems more plausible.

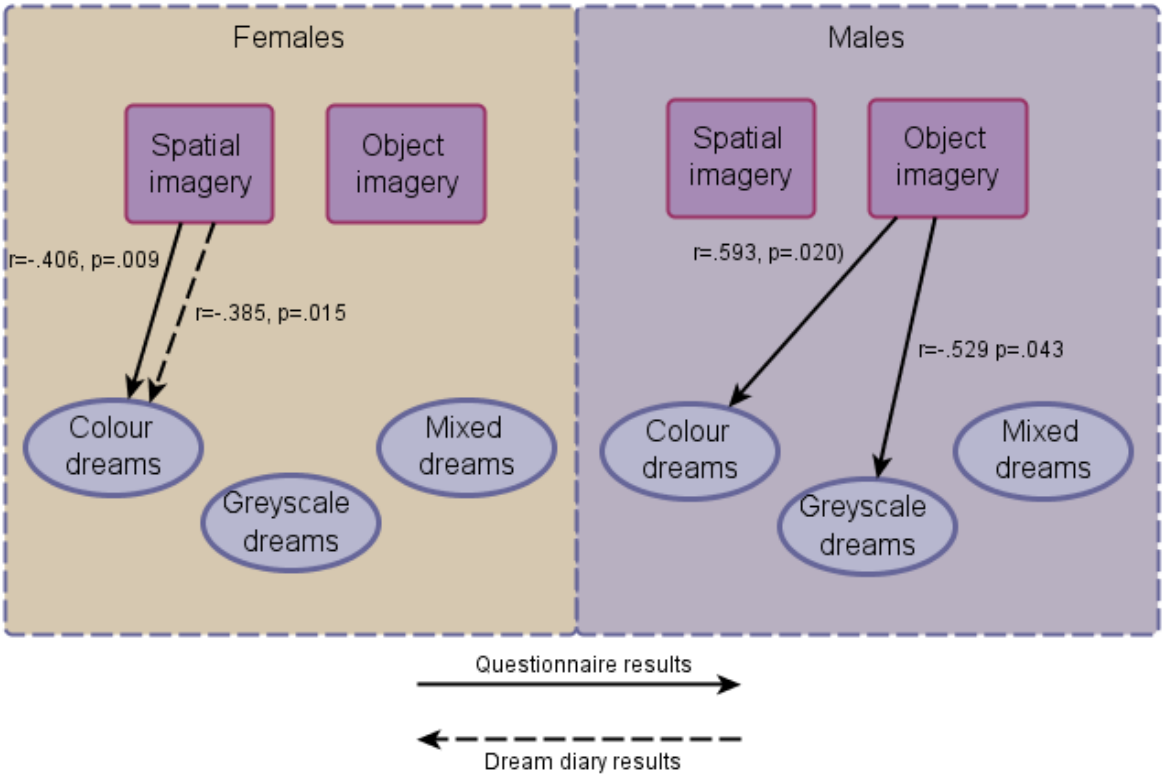


Figure 18: Correlation patterns of imagery preferences and dream colour for males and females

6.7.3.9 Dream colour and task measures of visual imagery and memory

Because neither of the OSIQ scales was found to be correlated with the two tasks of object recognition (that were purportedly measures of object imagery) and with the colour memory task, separate analyses of their possible relationships with dream colour were carried out. The most interesting results were provided by the colour memory task, since it was positively correlated with the questionnaire proportion of coloured dreaming (r=.272, p=.044). When the task performance was divided into colour errors (mistakenly recalling a colour picture as black and white) and black and white errors (mistakenly attributing colour to greyscale pictures), the colour errors scale was significantly negatively correlated with the questionnaire percentage of coloured dreaming (r=-.291, p=.031) and was positively correlated with dream

diary measure of greyscale dreaming (r=.345, p=.011). The black and white error score was only marginally correlated with the questionnaire estimate of mixed dreaming (r=.236, p=.082). This pattern is quite interesting, since it shows that accurate colour memory results in higher questionnaire estimates of coloured dreaming, but does not translate into more coloured dreams as reported in the diary. The tendency to misrecall coloured images as greyscale, however, is related both to lower questionnaire estimates of coloured dreaming as well as a higher greyscale dream proportion in the dream diary.

6.7.3.10 Video clip reports and imagery and colour memory

The video clip descriptions were coded in order to see whether the visual preferences and abilities would have an impact on how the uniform visual stimulus would be described across participants. When Object and Spatial imagery scores were correlated with the description features, only 2 correlations were visible – an almost significant negative correlation between spatial imagery and description word count (r=-.244, p=.072) and another almost significant negative correlation between the number of objects in the description and spatial imagery score (r=-.246, p=.070). The word count correlation might be related to the sex differences in description length and spatial imagery (females produced longer clip descriptions and have lower spatial imagery scores). The relationship between spatial imagery and object count can probably be partially accounted for by the former correlation as well – longer descriptions were usually filled with more items.

Out of the task indices of memory and imagery, only colour memory was found to be related to any of the description variables. Colour memory score was significantly positively correlated with word count (r=.293, p=.030) and with the number of objects present in the report (r=.360, p=.007) and almost significantly correlated with the number of colours

mentioned (r=.247, p=.070). Since colour memory was not correlated with either object or spatial imagery, these correlations are most probably a reflection of general memory ability. When the two error indices were analysed, only one correlation was significant: people who tended to mistakenly attribute colour to greyscale pictures also mentioned less colours in their video descriptions (r=-.295, p=.029).

6.7.3.11 Dream diary reports and measures of imagery and colour memory

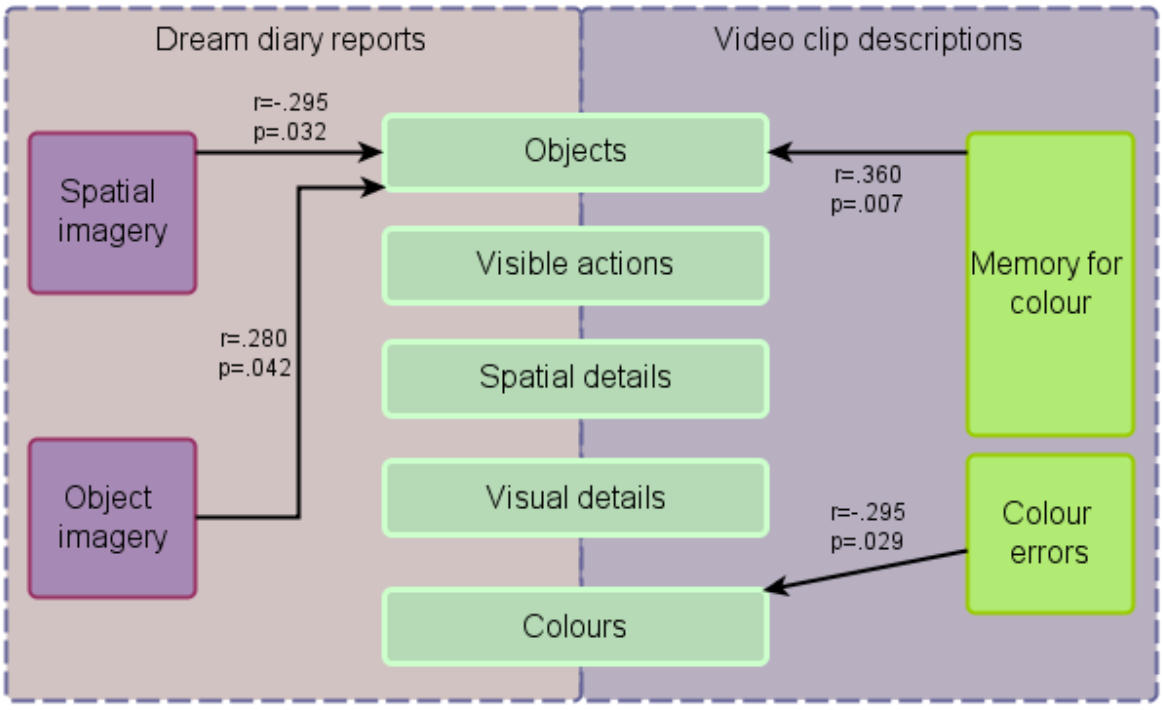
When the dream diary content is analysed for the relationships between visual elements and imagery, two relationships were found to be significant. First, Object Imagery score was positively correlated with the object count in the dream reports (r=.280, p=.042) and Spatial imagery score was negatively correlated with the same variable (r=-.295, p=.032). Additionally, there was a nearly significant correlation between object imagery and the number of colour terms used in the dream reports (r=.267 p=.056). Table 17 on page 165 shows the effects of Object and Spatial Imagery on both the video descriptions and the dream report text.

When visual memory was investigated, none of the visual memory measures (general score or the proportions of error types) were correlated with any of the diary measures of content, including word count. Figure 19 on page 165 presents the correlation patterns for the dream reports and video descriptions.

Table 18: Correlations of imagery preferences with dream report and video description visual features

	Word count	Objects	Actions	Spatial details	Visual details	Colours
			Video clip description			
Object imagery	r=.034 p=.804	r=-.002 p=.991	r=-.016 p=.906	r=-.026 p=.849	r=-.104 p=.452	r=.127 p=.356
Spatial imagery	r=-.244 p=.072	r=-.246 p=.070	r=-.166 p=.225	r=-.217 p=.111	r=-.152 p=.269	r=-.152 p=.269
			Dream diary reports			
Object imagery	r=.147 p=.292	r=.280* p=.042	r=.246 p=.076	r=.175 p=.209	r=.224 p=.108	r=.267 p=.056
Spatial imagery	r=-.231 p=.095	r=-.295* p=.032	r=-.164 p=.241	r=-.247 p=.075	r=-.249 p=.072	r=-.066 p=.641

Figure 19: Relationship pattern between memory, imagery and visual features of dream reports and video descriptions



6.7.3.13 Video clip descriptions and dream reports

One of the reasons the video clip description task was introduced was to investigate if there are similarities between the description styles used in the two otherwise different tasks. The variables under scrutiny are the number of words in description, number of visible objects, visible actions, spatial details, visual details and finally colour details. There are three possible ways of comparing the visual elements mentioned in the two written reports: correlating the raw values of each of the variables, correlate the percentage values of these variables (so, the number of objects per 100 words etc) and finally, doing a within-subject t-test to compare the percentage values across the two tasks. The first method provides information about the overall verbosity, since the numbers of words in each category are highly dependent on the overall description length. Predictably, all of the diary and video variables were positively correlated with the exception of colour words. This exception means that high colour word usage in one type of report did not match with a high usage of colour descriptions in the other, while the remaining variables were reasonably related.

When the proportion data was analysed, most of these correlations disappeared – with the exception of action and spatial details, which remained significant. This result means that as far as the density of different visual categories goes, only the proportions of action and spatial descriptions were related across the two types of text.

The final test demonstrated that, with the exception of colour terms, the proportion of different visual terms was significantly different across the two tasks. The lack of significant difference between the colour terms might stem from the overall low frequency of these terms and the high individual variability. Table 18 on page 167 presents the summary of correlations and within-group differences between the two types of descriptions.

Table 19: Relationships between the visual features of dream reports and video descriptions

	Objects	Actions	Spatial details	Visual details	Colours
Raw correlations	r=.469** p=.000	r=.469** p=.000	r=.511** p=.000	r=.336* p=.014	r=.104 p=.463
Correlations of percentage values	r=.045 p=.748	r=.495** p=.000	r=.391* p=.004	r=.224 p=.108	r=.177 p=.209
Results of t-test	t=11.976** p=.000	t=14.530** p=.000	t=11.738** p=.000	t=6.175** p=.000	t=1.545 p=.129

When all of these results are taken together, three conclusions can be drawn. Firstly, the differences in the description styles between the two tasks are quite large – the main factors are most probably the recency of the recalled material (since the video clip was described after an 8 minute delay, and the dreams were written down after a much longer delay), the interactivity and the type of content. In most dream reports, the description of feelings and other non-visual elements such as thoughts or judgements takes up more space than in the description of a non-personal video clip. Therefore, the raw proportions of space devoted to visual descriptions will differ. Secondly, the raw correlations between the numbers of visual description words in different variables across the dream and video clip reports are most likely the result of the text length influence. The description word count was significantly correlated across the diary and the video clip report ($r=.523$, $p<.001$) so it stands to reason that people who produced more text in both tasks would also end up with a higher raw count of visual descriptions for both. Therefore, the raw count correlations seem somewhat useless in finding out about potential links between the description styles. The final and most important point comes from the analysis of the correlations between the proportions of various visual descriptors. The complete lack of relationship between the object

proportions can be again attributed to the different nature of the task. However, the two significant correlations between the proportions of action and spatial descriptors suggest that there is some consistency between the two types of descriptions and people who use a lot of spatial and action phrases in dream reports also use more of those in the video description task. It is currently open to discussion why only the proportions of action and spatial phrases are linked in such a way.

6.7.4 Conclusions

The present study addressed a number of novel questions that emerged during the course of thesis research and attempted to replicate some of the more interesting results seen in the earlier studies.

One of the main aims of this study was to assess the reliability of the dream colour questionnaire in comparison to the dream diary. When the dream colour reports obtained through the questionnaire and dream diary were examined, it turned out that in the questionnaire people overestimated their frequency of greyscale dreaming. It is uncertain whether this difference was caused by the relatively short period of dream collection, by the forced choice design of the dream questionnaire by a genuine tendency to overestimate the amount of greyscale dreaming. Nonetheless, this result does give some credibility to the claims that at least some of the results obtained during ‘decades of greyscale dreams’ could be explained by the use of questionnaires to gather data.

A comment on the general frequency of coloured dreaming must be made here: the percentage of coloured dreams discovered in this study (74%) is much lower than the one in Schredl et al. (1998) investigation (95%). This is most probably due to the different way in which dream colour was assessed in both studies: Schredl and colleagues explicitly asked

dreamers to remember particular colours from their dreams and counted every dream report with any mentions of colour. The present study only counted as coloured dreams in which the dreamer expressed belief that the whole dream was in colour, otherwise they were assigned to the mixed dream category. When all dreams that contain mentions of colour are counted, the total rate for coloured dreams in this study comes to 90%, much closer to Schredl's findings.

The focal point of the study – the relationship between visual imagery and dream colour – has yielded some very interesting results. Firstly, both scales of the Object Spatial imagery Questionnaire were tied to the diary and questionnaire estimates of dream colour frequency. In the overall sample, high spatial imagery score was linked to more greyscale and less coloured dreams in the questionnaire and in the dream diary. When the analysis was carried out separately for males and females (due to sex differences in OSIQ scores) it turned out that the correlation patterns differ between the sexes. In the questionnaire data, spatial imagery was the main predictive variable for females, while for males object imagery was the variable that was correlated with dream colour. In the diary data, only spatial imagery score was related to dream colour in females, and there were no significant results for the male subgroup. This pattern of correlations hints at how gender models influence the way participants approach the instruments that measure abilities considered to differ between sexes and it highlights the importance of taking sex differences into consideration when looking at the possible causes of greyscale dreaming. Most importantly, the results of this analysis replicate the findings from study 3 and 5 and provide more evidence (this time diary evidence in addition to questionnaire) that visual imagery style has an impact on the reported dream colours, both in questionnaires and in morning dream diaries.

The fact that memory for the presence of colour was related to the questionnaire estimates of dream colour is also a very important finding. Not only is the general ability to recall the

colouration of an image related to coloured dreaming, but also the propensity to recall coloured pictures as black and white is correlated with greyscale dreaming. This finding provides evidence for the memory-driven explanation of greyscale dreaming (people report greyscale dreams because they don't recall the colour in dreams) but only for the questionnaire measures of dream colour. Considering that the questionnaire dream colour estimates also inflated the percentage of greyscale dreams, it stands to reason that the difference between the questionnaire and diary estimate of dream types might be explained precisely by the tendency to misinterpret their dream memories as greyscale.

When the effects of visual imagery abilities on the visual descriptions were analysed, no relationships as strong and straightforward as in the previous studies (see study 5 for example) were found. In general, better spatial imagery was related to fewer dream visual details in general, which could be attributed to the sex differences in imagery and dream length – although similar correlation patterns were evident when dream length was accounted for. The lack of expected positive correlations between spatial imagery and actions/spatial details shows that in this study the more subtle interactions did not come through in the same way as they did in study 4, and instead the object-spatial imagery variables were only predictive of overall dream recall quality. One of the possible reasons for this pattern is the freshness of recorded dreams: in the study that did find the expected relationships, only dreams older than 3 days displayed those correlations, while the more recent dreams did not. It is likely that imagery preferences thus do not influence dream visual content and immediate recall as much as it filters and modifies dream memories across longer time spans. More research taking recent and older dreams from the same people and comparing them would be useful to fully solve this question.

The introduction of the video clip description as a comparison to the dream reports has also provided some interesting results that back up the general conclusions regarding imagery abilities and visual dream content. Object and spatial imagery measures were only marginally related to the visual content of the descriptions, and could once again be interpreted as correlates of general recall ability and description length. Colour memory (which is in a way a measure of general detail memory) had a much stronger influence on word count, objects and colours mentioned. The fact that imagery preferences did not influence description style in this recent recall task strengthens the hypothesis that this particular cognitive style influences how memories are recalled after some time (or after a few recall repetitions) rather than strongly influence what is noticed and immediately recalled. Once again, further research would be needed to compare descriptions of recent events with those of more dated ones.

CHAPTER 7: COMPARISON OF STUDY RESULTS

In this thesis seven studies that investigated greyscale dreaming and dream visual content were completed. The studies used slightly different methodologies and were carried out on differing samples, but a lot of them gathered data using the same instruments or yielded data that can be easily compared to that from other studies. In this chapter I will contrast the results of the various studies and where appropriate, analyse some of the data together to obtain larger sample sizes. The main reason for comparing the data and results obtained by the various studies to see how methodology and dream report type used impact the findings. The findings that will be analysed will be grouped into four sets: the impact of black and white media and age, the effects of visual memory, visual imagery and dream colour and finally, visual imagery and dream visual content.

7.1 Black and white media & age

The relationship between dream colour and experience with black and white media was addressed in almost every study, but because of the narrow age samples in some of the projects, it was fully investigated only in studies one, two, three and six. The first and third study compared the dream colour of two age groups, while the second and sixth study analysed a wider age group. Because of the different methods employed and the differences in group composition, a few different variables were used as a way of quantifying media influence. Table 19 on page 173 presents the summary of the groups analysed and the results obtained in each of the studies.

Table 20: Summary of dream colour findings from 4 studies

Study	Measure of dream colour	Sample	Frequency of colour and greyscale dreaming	Relationships detected
1	Dream diary	Group 1: n=30, mean age=21.45, SD=2.53	Colour dreams: 68% (SD=31.80) Greyscale dreams: 4.5%, (SD=9.01)	Access to B&W media before coloured media was the decisive factor. People in the older group who had no such access had a similar rate of dream colour as the young group.
		Group 2: n=30, mean age=64.17, SD=8	Colour dreams: 34% (SD=36.86) *Greyscale dreams: 22.1%, (SD=27.13)*	
2	Questionnaire	Total sample: n=130, mean age=47, SD=6	Colour dreams: 64% (SD=41.21) Greyscale dreams: 13% (SD=25.32)	Time spent with black and white media was correlated with frequency of greyscale dreaming, but only for participants with high confidence in their assessment of dream colour (r=.328, p=.028).
		High confidence sample: n=47, mean age=48, SD=5	Colour dreams: 67% (SD=38.79) *Greyscale dreams: 17% (SD=27.57)*	
3	Questionnaire	Group 1:n=19, mean age=21.42, SD=2.06	Colour dreams: 66% (SD=36) Greyscale dreams: 18%, (SD=26)	No significant relationships between media access and dream colour were found.
		Group 2: n=20, mean age=55.30, SD=11.38	Colour dreams: 50% (SD=39) *Greyscale dreams: 34%, (SD=36)*	
6	Questionnaire	n=24, mean age=44.50, SD=10	Ordinal scale was used to assess the frequency of various dream colour types.	Age of colour media access was negatively correlated with the percentage of coloured dreaming (r=-.423, p=.063)

The major challenge in analysing the influence of media on dream colour is the constant possibility of the interference of age. Even though ageing processes should not significantly influence the mechanisms responsible for dream recall in the age range that was investigated during this thesis, the possibility of such impact has to be kept in mind. And, in the western world, age is nearly always correlated with the history of access to black and white media. Therefore, it is not enough to carry out comparisons between different age groups – the relationship between media access and dream colour should ideally be found regardless of age, within older groups. When the results of the four studies are summarised, it becomes evident that only the first study had managed to fulfil that condition. In that study the age differences that were found in the frequency of greyscale dreaming were overshadowed by the differences between people who had early access to black and white media and those who did not, regardless of age. The older participants who had started off with access to colour media had the same pattern of recalled dream colour as the young participants did. The length of sole black and white media access was moreover related to the percentage of mixed colour dreams a person reported in their diary. Finally, the unique (in this thesis) investigation of dream recall quality and colour suggested that there are differences in how people classify their dreams according to the recalled visual characteristics – people who have had black and white media access recall their colourless dreams as well as the coloured ones.

When the remaining studies are examined, the results are not so straightforward. The second study examined a group of mostly middle aged adults to see if the group differences could be also translated into a correlational relationship between media access and dream colour. None of the expected effects appeared in the data, neither for the correlations nor for group differences. Because the previous study had used a morning dream journal to assess dream colour it was thought that perhaps people are having problems with accurately judging

their dream colour and estimating the proportions of the different colour types of dreaming. Thus, the data were reanalysed, using only the cases where people had expressed reasonable confidence in their dream experiences. In this subset, a significant relationship emerged between the time spent with black and white and the percentage of greyscale dreams – such a relationship had been found in the first study, but for mixed dreaming only. This inconsistency may seem puzzling, but it can be solved by looking at the methodology employed in the studies. In the first study, the colour type of each dream as determined by the researcher, basing on the information provided by the participants in the morning recall. In the second study, the participants were estimating not only the proportion of the three types of dreaming, but also the classification of their dreams. It is possible that dreams that on morning recall would have been classified as mixed or even in full colour end up being recalled as greyscale during the day.

The third study aimed to replicate the findings of the first one but did not manage to fulfil that expectation. Even though the average rates of colour and greyscale dreaming in the old and young groups were comparable across the first and third study, there were no significant age differences detected in the latter due to a much higher within-group variance and a smaller group size. Once again, it is possible that the questionnaire methodology further obfuscated any possible relationships but in this small sample it was impossible to select cases basing on the expressed confidence.

The last study that directly addressed the relationship between dream colour and media access used a small sample of Polish adults with very high levels of early black and white media experience. Because the instrument used to gather data about dream colour put it on a ordinal scale, to properly compare those results it was necessary to transform the data from the other three studies onto the same scale. When that is done, it becomes visible that the

Polish adults report higher rates of greyscale (Mann-Whitney U=652, Z=-4.065, p<.001) and mixed dreaming (Mann-Whitney U=674, Z=-4.080, p<.001) than the British adults in similar age range. They had also gained access to colour media significantly later than the British adults (age 15.5 as compared to 9.5 in the British sample) and had spent more time with black and white media only (7 years vs. 4.8). The amount of colour dreams in the Polish group was negatively correlated with the age of colour media access – so, the later a person had gained regular colour television or cinema access, the fewer colour dreams they report. Because the age of the two groups was very close, and both groups consisted of middle aged adults, it would be hard to argue that age is the reason behind the greyscale dreaming reports. It would be possible to argue that the Polish culture encourages the recall of greyscale dreams, but there is little evidence for that. When colour media was introduced, it was a lengthy process that was years behind the Western Europe and people had full awareness of black and white media being 'second rate'. The traditional Polish 'good night' saying can be translated as 'have colourful dreams' (equivalent of 'sweet dreams') and although this evidence is mostly anecdotal, it is hard to argue that there were strong cultural factors operating to suppress colour dreaming reports.

Overall, the evidence for the impact of black and white media on dream colour is promising, but not conclusive. Even though there were no results that would outright clash with the media hypothesis, there is little consistency across studies in which proxy variable of black and white media experience (age of colour media access, time spent with black and white media, access to black and white media) is related to the occurrence of coloured or greyscale dreaming. And while the data does show that age is not a major factor in dream colour, there are still issues that have to be addressed before the hypothesis that greyscale dream reports are a result of black and white media influence is fully supported. The fact that

the diary study had also yielded the clearest results is encouraging, but more dream journal studies would have to be carried out in order to solve the question.

7.1.1 Pooled data analysis

Because so many studies did not find any significant effects due to issues with sample size or composition, it was decided that creating a larger data pool from all of the studies might be conductive to solving some of the uncertainties that remained. The main questions that were investigated were whether age was a factor in greyscale dreams and whether a person's experience with black and white media was related to their dream colour profile.

To carry out this analysis, all the data from studies 1-3 and 5-7 was pooled and reduced to the simplest nominal level for the relevant variables: experience of the various types of dreaming (colour, greyscale or mixed) and exposure to black and white media (having access to black and white media before colour media). The dataset included 255 cases and consisted of 163 females and 93 males. 57 people were under 25 years of age, 109 were between 25 and 50 and the final 89 cases were aged over 50.

To check whether age was related on dream colour, the data set was split according to the age groups and independent t tests were carried out to see if people who reported having greyscale dream were perhaps older than those who claimed not to have such dreams. In the over 50's group, there were no differences in age ($t_{(87)}$=1.020, p=.310); similarly there were no age differences in the middle age group ($t_{(107)}$=.356, p=.722). Interestingly, there was a significant age difference in the group of people under 25 years ($t_{(54)}$=-2.804, p=.007), with those who reported having greyscale dreams being on average 22.3 years old, while those who did not report such dreams were 20.8 years old.

Chi-square tests were calculated for each age group to see if access to black and white media is related to more greyscale and mixed dreams. In the youngest and the middle age groups there were no significant relationships between any of the dream colour types and access to black and white media. However, in the oldest group both greyscale and mixed dream experience were more likely if a person had early black and white media access. The Table 20 below presents the details of the relationships.

Table 21: Results of chi-square tests for age and dream colour

	Age >25	Age 25-50	Age>55
Colour dreams	$c^2_{(1,N=57)}$=.115	$c^2_{(1,N=109)}$=.011	$c^2_{(1,N=89)}$=1.805
	p=.897	p=.640	p=.163
Greyscale dreams	$c^2_{(1,N=57)}$=1.583	$c^2_{(1,N=109)}$=.002	$c^2_{(1,N=89)}$=8.361*
	p=.225	p=.569	p=.004
Mixed dreams	$c^2_{(1,N=57)}$=.316	$c^2_{(1,N=109)}$=1.720	$c^2_{(1,N=89)}$=6.029*
	p=.513	p=.140	p=.014

As it can be seen from this data, having had access to black and white media entails a higher likelihood of reporting greyscale and mixed dreams only in the older age group, which is consistent with the interpretation that the impact of media should only be detectable within the older population that has actually had significant access to black and white entertainment. This result, combined with the lack of age differences between people who report greyscale and coloured dreams provides further strength for the idea that media had an impact on how dreams are now reported.

7.2 Colour memory and dream colour

The relationship between memory for colour and dream colour was investigated in the third and seventh study. In both studies incidental memory for the presence of colour was examined in an attempt to achieve a higher degree of validity than the previous studies of visual memory and dream recall. The third study used only a questionnaire assessment of dream colour, while the last study employed both a questionnaire and a dream diary, allowing to compare the impact of visual memory on dream colour in both of these methods. Table 21 on page 180 presents the summary of correlations found in the two studies.

It becomes visible that in the first study, no significant relationships between the recall or recognition of image colour type and the reported dream colour emerged. The negative relationship between recall of image colour and percentage of greyscale dreaming hovers around significance, but little can be concluded from it, especially that the final study did not find a corresponding significant relationship in a larger sample. This sub-significant correlation of recall and dream colour was promising due to the face validity of recall measures in dream research and was pursued in the last study, which found a series of significant correlations between both general accuracy in colour memory and the pattern of errors committed and the colour of dreams. In the questionnaire data, the rate of colour dreaming was positively correlated with the overall accuracy, and negatively with the tendency to recall coloured pictures as black and white. This result is in line with the ‘immutable dreams’ theory since memory failure is seen as the most important cause of contemporary greyscale dream reports.

Table 22: Summary of correlations between colour memory and dream colour

	Percentage of colour dreaming	Percentage of greyscale dreaming	Percentage of mixed dreaming
	Study 3, n=49		
Recall of image colour	r=.163 p=.334	r=-.270 p=.105	r=-.032 p=.851
Recognition of image colour	r=.055 p=.738	r=-.045 p=.784	r=-.072 p=.664
	Study 8 – questionnaire data, n=55		
Recall of image colour	r=.272* p=.044	r=-.197 p=.149	r=-.161 p=.242
Colour errors	r=-.291* p=.031	r=.212 p=.120	r=-.009 p=.949
Black and white errors	r=-.139 p=.312	r=.099 p=.470	r=.236 p=.082
	Study 8 – dream diary data, n=55		
Recall of image colour	r=-.002 p=.987	r=-.119 p=.393	r=-.064 p=.647
Colour errors	r=-.058 p=.678	r=.345* p=.011	r=-.002 p=.991
Black and white errors	r=.053 p=.702	r=-.130 p=.348	r=.092 p=.507

Interestingly, the questionnaire frequency of mixed dreams was also positively correlated with the tendency to misrecall black and white images as coloured. This could mean that what people describe as dreams that mix colour and greyscale elements were in fact greyscale dreams that were modified in memory to include some colour elements. This is

unexpected, because the main account of mixed dreams claims that these are in fact fully coloured dreams from which people recall only the most salient colour elements and mistakenly labelling the rest as devoid of colour. More research into the what dreams are labelled as ‘mixed’, whether they are an actual separate dream colour type or what individual characteristics might prompt people to label colour or greyscale dreams as being a mixture of both. The analysis of the dream diary data revealed only a single significant relationship between colour memory and dream colour – reporting of greyscale dreams was correlated with the tendency to misrecall coloured pictures as black and white.

There are two points that need to be discussed here. Firstly, the difference between the patternw of correlations for the questionnaire and diary data is interesting. The occurrence of the three types of dreaming is naturally correlated, since their sum must always be 100 %, so the differences in which one is correlated with the memory variables are puzzling. It seems that the variable that is the most reliable measure of dream colour changes between the diary and questionnaire, which is quite likely seeing that in the questionnaire people estimated their dream colour individually and in the diary the colour of their dreams was deduced from the information the participants provided for each dream they recorded. Moreover, the questionnaire had no option to answer ‘I don’t know’ regarding own dream colour. While the dream journal dream colour estimates are more accurate than the questionnaire ones, the correlation between colour memory and dream colour suggests that even the morning reports exaggerate the actual rate of greyscale dreams. The second point is the dream journal correlation itself – the relationship between errors in recall of coloured images and the reporting of greyscale dreams is very much in line with the proposed ‘conservative’ explanation for greyscale dreaming. In this explanation (as presented in chapter 3) people only experience coloured dreams and any greyscale reports are a result of factors such as

visual memory of societal pressure at work. This finding provides some confirmation to this idea. However, because only young people were examined in the study that found this relationship, it is difficult to say whether the same process operates in older people (who report more greyscale dreams than young people do, and who have a potentially valid reason to experience actual greyscale dreams).

7.3 OSIQ and dream colour

The relationship between visual imagery preferences, exemplified by the spatial and object imagery scale, and dream colour has been investigated in five studies. Two of these studies used dream journals (personal or kept for the study) and three were based on questionnaire self-report data. Table 22 on page 184 presents the summary of findings across the five studies, without going into the sex differences in correlations patterns found in the final study.

The first obvious conclusion is that the smaller scale studies did not find the hypothesised relationships between dream colour and visual imagery preferences. In the case of the 6th study, carried out with Polish adults, it is possible that the strong influence of black and white media experience made any imagery influence undetectable. In the 5th study there is no reason why the relationships are not appearing, so the most logical conclusion is that the power was insufficient to detect the correlations.

Table 23: Summary of findings for imagery preferences and dream colour

	Colour dreaming	Greyscale dreaming	Mixed dreaming
	Study 3, n=49		
Object Imagery	r=.361* p=.024	r=-.224 p=.132	r=-.191 p=.245
Spatial Imagery	r=-.126 p=.445	r=-.083 p=.616	r=.410* p=.010
	Study 4, n=81		
Object Imagery Spatial Imagery	People who report only coloured dreams have lower spatial imagery score, $t_{(76)}$=-1.81, p=.074		
	Study 5, n=23		
Object Imagery	r=-.037 p=.864	r=-.214 p=.316	r=.324 p=.123
Spatial Imagery	r=-.070 p=.744	r=-.106 p=.622	r=.202 p=.343
	Study 6, n=24		
Object Imagery	r=.280 p=.232	r=.034 p=.893	r=-.255 p=.359
Spatial Imagery	r=-.086 p=.718	r=.083 p=.744	r=.037 p=.895
	Study 7 questionnaire, n=55		
Object Imagery	r=.154 p=.262	r=-.148 p=.282	r=-.037 p=.790
Spatial Imagery	r=-.373* p=.005	r=.335* p=.012	r=.066 p=.630
	Study 7 dream journal, n=55		
Object Imagery	r=-.001 p=.996	r=.033 p=.813	r=.100 p=.473
Spatial Imagery	r=-.316* p=.020	r=.236 p=.085	r=.196 p=.156

The second issue is the inconsistency of which imagery variable is correlated with dream colour. In the 3rd study, Object imagery was correlated with more coloured dreams, while Spatial imagery was linked to more mixed dreams. In the 7th study, Object imagery was not correlated with any dream type, but Spatial Imagery score was the main predictive variable – it was negatively correlated with frequency of coloured dreams and positively correlated with the frequency of greyscale dreams. Spatial and Object imagery scores are typically negatively correlated, so it would be reasonable to expect double correlations in most of the studies – coloured dreaming being positively related to object imagery and negatively related to spatial imagery, but this is not the case. The more in-depth look at the interaction between sex and OSIQ correlations in study 7 has demonstrated that the self-report nature of the Object Spatial Imagery Questionnaire might results in the introduction of biases that render one (or both) scales unusable. This happens if there is a cultural script that interferes with the participant's ability to accurately judge their imagery abilities and instead prompts them to answer in a culturally appropriate way – for example by decreasing the variability in object scores in females and in spatial scores in males. It is thus possible that the different correlation pattern between study 3 and 7 is a result of group differences – the third study examined people over 50 along with people under 20, while the last study was carried out on student population only. Additionally, there were different proportions of males and females in both groups, and since dream colour was differently related to imagery skills in males and females in study 7, it is possible that it could have impacted the results.

The final issue worth mentioning is the similar pattern of correlations in dream journal and questionnaire data in the last study. This is in contrast to the different results obtained for the impact of visual imagery on dream visual detail through morning dream reports and most recent dream forms. In both sets of data, spatial imagery was positively linked with greyscale

dreaming and negatively correlated with colour dreaming, and the correlations were only slightly lower in the journal data. This finding is important because it means that imagery preferences might play a role in how dreams are experienced, and not just recalled. If the questionnaire data presented a relationship between imagery and dream colour, it would be safe to conclude that visual imagery preferences impact the way the overall dream life is assessed, for example by biasing the participants to recall dreams more in line with their imagery style. But since the relationship is also present in the morning recall dreams, the possibility that visual imagery genuinely affects dream generation process becomes much more likely. While morning dream recall data is still more prone to recall bias than REM awakening reports, this result is interesting enough to be pursued further. While REM awakening paradigm as done in a sleep laboratory is time and resource consuming, there is a viable home alternative that uses self timed or phone call awakenings to catch people in (presumably REM) sleep and gather dream reports straight after awakening.

7.4 OSIQ and visual dream content

The relationship between visual imagery preferences and dream visual content was introduced in study 4 and then pursued further in studies five, six and seven. The idea behind these investigations was that just as visual imagery preferences seemed to influence reported dream colour, they might have a more detectable impact on the amount of visual or spatial details in dream reports, either through selective memory preferences or through a genuine impact on what visual details are generated in the dream. This influence would be detectable by a content analysis carried out on dream reports. It was predicted that a high spatial imagery score would be accompanied by more spatial details in the dream descriptions; and that a high object imagery score would result in more vivid visual details and colour descriptions within the dream reports. Two of the studies (study 4 and 6) used the most recent dream method of obtaining dream reports, and two made use of the dream journal approach, with study 5 gathering personal dream journals and study 7 tasking the participants with keeping a dream journal for a specific time period. Out of the studies that have been carried out, only the 4th and 6th studies found the hypothesised relationships in the data. Study 5 did not find any significant relationships and study 7 provided some mixed results. Table 23 on page 188 shows a summary of sample sizes and the results of each of the studies.

Table 24: Summary of findings for visual imagery preferences and dream visual features

	Word count	Objects	Actions	Spatial details	Visual details	Colours
Study 4, n=81, average dream length: 140 words (SD=55)						
Object imagery	r=.086 p=.444	r=-.055 p=.627	r=-.018 p=.874	r=-.085 p=.452	r=.136 p=.224	r=.138 p=.218
Spatial imagery	r=.093 p=.410	r=.184 p=.100	r=.195 p=.081	r=.183 p=.103	r=-.097 p=.389	r=-.217 p=.052
Study 4, dreams older than 3 days, n=35						
Object imagery	r=.032 p=.856	r=.011 p=.949	r=-.060 p=.734	r=-.132 p=.448	r=.108 p=.537	r=.117 p=.503
Spatial imagery	r=.107 p=.540	r=.325 p=.057	r=.316 p=.064	r=.405 p=.016	r=-.090 p=.609	r=-.335 p=.049
Study 5, n=23, average dream length: 292 words (SD=93)						
Object imagery	r=.045 p=.838	r=.243 p=.265	r=.108 p=.623	r=-.012 p=.956	r=.035 p=.452	r=.064 p=.773
Spatial imagery	r=-.344 p=.108	r=-.128 p=.405	r=-.197 p=.369	r=-.136 p=.537	r=-.203 p=.354	r=-.159 p=.469
Study 6, n=24, average dream length: 73 words (SD=42)						
Object imagery	r=.216 p=.347	r=.135 p=.559	r=.281 p=.217	r=.125 p=.590	r=.386 p=.084	r=-.033 p=.889
Spatial imagery	r=-.084 p=.717	r=-.147 p=.525	r=.035 p=.879	r=-.030 p=.879	r=-.093 p=.689	r=-.597 p=.004
Study 7, n=55, average dream length: 151 words (SD=68)						
Object imagery	r=.147 p=.292	r=.280 p=.042	r=.246 p=.076	r=.175 p=.209	r=.224 p=.108	r=.267 p=.056
Spatial imagery	r=-.231 p=.095	r=-.295 p=.032	r=-.164 p=.241	r=-.247 p=.075	r=-.249 p=.072	r=-.066 p=.641

The first thing that needs to be mentioned is the tendency for Object and Spatial imagery scales to switch their predictive values across studies. Study 7 has demonstrated that the two imagery variables show different predictive properties for men and women when dream colour is concerned, and since different studies had varying proportions of males and females it is possible that it could have had an impact on which imagery score was more important.

The most constant result that was found across almost all studies is the set of correlations between imagery style and the number of colour terms mentioned in the reports. In three studies the variable negatively correlated with colour details was spatial imagery, and in one study object imagery was positively correlated with colour detail. This interchangeability of the two imagery variables across studies is something that was already pointed out in the review of how imagery impacts dream colour. In this case, the spatial imagery variable was a significant factor for colour details in the Most Recent Dream paradigm, while object imagery was significant for dreams gathered with a morning dream journal approach. Setting the problems with the OSIQ scales aside, this result is strong and significant across three studies, providing some support towards the idea that visual imagery shapes how dreams look like.

The second promising (albeit not significant) finding was that of visual detail being positively correlated with Object imagery in study 6 and negatively correlated with Spatial Imagery in study 7. This correlation goes in the expected direction in both cases, even though the imagery variable it depends on changes and is consistent with the findings relating to colour terms. However, this is the last consistent finding across the studies due to the unexpected correlations found in the last study. In the final study, the length of the dream reports was negatively correlated with the participants' spatial imagery score. Because the

length of the dream report is at the same time naturally correlated with the numbers of visual descriptions of different kinds, this intercorrelation has the potential to cause superficial correlations between spatial imagery and the content variables to appear. This superficial correlation is probably the reason behind the discrepancies between a few results from the 4th and 7th studies.

The first discrepancy is in the relationship between Spatial Imagery and the amount of spatial details present in the dream reports. In the Most Recent Dream study, the number of phrases describing spatial relationships was positively correlated with spatial imagery score, as was originally predicted – in the dream diary study, however, it was negatively correlated with spatial imagery. The negative correlation was nearly significant and much lower than that obtained in the 4th study, and therefore it is quite likely that is just an artefact of the dream length association.

The correlation pattern for visible actions within dream reports is a bit less straightforward. In the 4th study, a small positive sub-significant relationship between spatial imagery and visible actions was found – and a similar positive relationship between object imagery and actions was discovered in the 7th study. These correlations are completely opposite, since object imagery is usually negatively correlated with spatial imagery scores. The correlations between visual imagery and the number of objects in the dream present a similar puzzle. There are two possible explanations for this issue. The first one is to account for these differences by invoking the way the dream reports were obtained – the 4th study employed the most recent dream paradigm, and the 7th study gathered morning dream reports. It is possible that the mechanism in which visual imagery preferences operates changes with dream report recency, and that in reports of very recent dreams object-spatial imagery serves as a measure of overall dream recall detail (high object imagery being related to more details,

high spatial imagery to less details). The predicted, straightforward relationships between the visual dream details and imagery styles would only appear after the dream has been recalled a few times (or some time has passed), when the repeated recall would reconstruct the dream memory in line with imagery preferences. The idea that Object Imagery can serve as a measure of general detail memory is not without basis – a lot of the questionnaire items that factor into Object Imagery score ask about visual memory, for example 'I have a photographic memory' or 'I can easily remember a great deal of visual details that someone else might never notice.'. If this is the case, the lack of correlation between Object Imagery and colour memory (and visual memory and dream content variables) becomes quite interesting, since it should be present if Object Imagery scale and visual memory are overlapping. This lack of relationship can be explained if the colour memory task used in the last study tapped into short term memory skills, while the Object Imagery scale also measures the attention paid to visual content and the ability to easily recall and encode such details. Overall, this line of explanation of the difference in correlational patterns across the 4th and 7th studies has the potential to become an interesting research avenue, since more studies would need to be done to confirm whether the interplay between the predictive value of OSIQ and dream recency is indeed present.

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7.5 Different measures of dream colour

The final comparison that can be drawn between studies concerns the accuracy of questionnaire and dream diary results when assessing dream colour. Two studies (the first and the last one) have gathered information about dream colour using two methods – a self assessment questionnaire and a morning dream journal, making it possible to find out how much the method of obtaining dream colour information impacts the people's responses. Table 24 presents the results of both studies as proportions of people who experience given types of dreams, while Table 25 on page 193 compares the average dream frequencies from study 7.

Table 25: Comparison of dream colour findings for diary and questionnaire measures

	Questionnaire	Dream journal
Study 1	48% have only colour dreams	37% have only colour dreams
n=60	7% have only greyscale dreams	0% have only greyscale dreams
mean dream journal	30% have both types of dreams	58% have both types of dreams
records: 11	15% don't know	5% don't know
Study 7	27% have only colour dreams	49% have only colour dreams
n=55	0% have only greyscale dreams	2% have only greyscale dreams
mean dream journal	73% have both types of dreams	49% have both types of dreams
records: 4.5		

Table 26: Comparison of questionnaire and diary estimates of dream type frequencies for study 7

	Average percentage reported in questionnaire	Average percentage found in diary
Colour dreams	80%	74%
Greyscale dreams	13%	5%
Mixed dreams	16%	16%

The dream colour frequencies obtained in both studies are naturally quite different, since the 1st study was a cross-sectional analysis of two age groups while the last study only investigated dream colour in young adults. The first study also used a very simple version of dream colour questionnaire, which yielded only nominal data about the overall dream colour of participants. The last study, on the other hand, gathered scale data as the participants rated their frequency of the three types of dreaming. Therefore, the questionnaire results from study 7 are presented both unmodified and collapsed to a nominal level to make them easier to compare.

In the first study, it seems that some people discovered that their dreams are more varied than they claimed in the questionnaire: the number of people who claimed to have only coloured dreams, only greyscale dreams or who could not identify their dreams decreased between the questionnaire and the dream diary. The last study reported a reverse trend: the proportion of people claiming to have both types of dreams decreased substantially, and the percentage of people recording only coloured dreams increased. There are two possible interpretations of this difference. Firstly, the studies investigated different age groups. In the 1st study, half of the participants were over 55 years of age and there was an overall high frequency of greyscale dreaming in the older group. Thus, it is possible that in the first study

questionnaire some of the older people falsely believed they only have greyscale dreams, but when the morning journal focused their attention on dreaming, they discovered they do have coloured dreams. The younger group on the other hand overestimated their frequency of coloured dreaming and while keeping the journal found the more uncommon mixed or colourless dreams. While this explanation accounts for the findings in the 1st study, but cannot explain why an almost opposite effect occurred in the 7th study.

The second reason for the difference lies in the construction of the questionnaire. In the first study, participants had to say if the dreams were 'in colour' 'black and white' or 'both' which could lead them to ignore or forget their experiences of dream types uncommon for them. These dream types would be subsequently recorded in the dream diary, producing the effect of increasing the proportion of people who experience both colour types of dreams. In the last study, the questionnaire prompted the participants to estimate the experience and proportion of three types of dreams (colour, greyscale and mixed) separately, which could lead to the participants claiming that they do experience those dreams 'just in case'. There were a lot of participants who, for example, wrote that 2% of their dreams are greyscale and indicated that their confidence in their ratings is very low (1 or 2 on the scale). It is difficult to say whether the diary didn't pick up those dreams because they are so uncommon or because the participants don't actually experience them, and just claimed so to be safe. The length and structure of the dream journal is the third explanation. In the first study, the participants were not asked to write down the content of their dreams, but to rate each dream they recall on a variety of points and to record any colour qualities of the dream. This resulted in a very high rate of dream recall, as the participants were encouraged to record even faintly remembered dreams. Moreover, the study length was 10 days, giving an average of 11 reports per person. In the last study, the participants had to write down each dream they had for seven days or

until they gathered 10 dreams, resulting in a lower dream recall rate as they probably did not want to write down very faintly recalled dreams. In the end, the mean number of dreams contributed was 4.4. This difference in the number of dreams recorded can produce large differences in the reliability of the diary data for assessing the prevalence of various dream colour types. In the 1st study, because of the higher number of recorded dreams, it becomes more likely to obtain reports of infrequent dream types, or of dreams that are poorly recalled. In the second study, with the average dream report number of 4.5 and the shorter gathering period is becomes very likely that rare dream types will be missed. Therefore, people who have said they experience both colour and greyscale dreams in the questionnaire might record only colour dreams in the diary, even though they do occasionally experience greyscale dreams. It would be necessary to keep both types of dream diaries for a longer period of time to assess whether the inclusion of poorly recalled dreams (that were judged impossible to write down) makes the journal results more accurate, or introduces unreliable data, since poorly recalled dreams can be wrongly classified as greyscale due to the lack of sufficient visual details recalled.

When only the separate dream type frequencies from the 7th study are considered, it becomes visible that the questionnaire data is very close to the diary data, with the exception of greyscale dreams which decrease in frequency. This might be due to the participants discovering, upon careful morning consideration, that they in fact have mostly coloured dreams. However, due to the dream sample size issues discussed in the previous paragraph it becomes quite likely that the diary did not capture enough dream reports to provide a reliable estimate of the prevalence of dream colour types.

Finally, the issue of reporting bias has to be discussed. In both of the studies, the participants completed the questionnaire before they kept the dream journal. The order of administering

the measures of dream colour was chosen because it was the simplest way to gather data from a student sample. This order introduces a possible bias issue – because the participants have an opportunity provide an assessment of their dream colour at the beginning, they might become biased to keep in line with their initial assessment when recording the journal dreams. This effect would artificially inflate the agreement rates between the diary and the questionnaire results. However, for this bias to have a strong effect the participants would have to remember their questionnaire answers, to which they had no access. While it is reasonably easy to expect that they would remember their answer regarding the overall dream colour, as they provided it in study 1, it is less probable that they would remember the detailed proportions of dream colour they provided in the last study. When the dream colour rates are compared across the two methods, the agreement is modest at best when only the experience is considered, and quite good when the frequency is examined (data from study 7). Thus, the bias issue is most probably not a huge factor, although it has to be acknowledged as a possibility.

CHAPTER 8: GENERAL DISCUSSION

This thesis set out to investigate the influence of black and white media on dream colour, and during the course of the studies it shifted and broadened its scope to include individual differences in memory and visual imagery preferences. What started as a straightforward attempt to solve one question (was black and white media responsible for the surge of greyscale dreams?) ended up addressing many factors that play a role not just in the colour of dreams, but also in the general visual properties of dreaming. While few of the questions that have been asked were answered conclusively, many new and interesting avenues have been opened up for further research that has the potential to add to the existing models of dreaming. In this chapter, I will summarise each of the main factors investigated to see what insights into dreaming and visual consciousness can be drawn from this research, and then discuss how the evidence gathered in the course of this thesis reflects on the three theories of dream colour introduced in chapter 1.

8.1 Black and white media

The influence of black and white media was one of the first hypothesised explanations for the sudden changes in the reporting of coloured and greyscale dreams during the 20th century. This explanation is relatively simple, it clearly accounts for both the rise and the fall of greyscale dream reporting and it can also contribute to our understanding of the current age and cultural differences in dream colour. However, many researchers treat it with great caution (Schwitzgebel, 2003). There are two main reasons why the media influence hypothesis seems difficult to accept. The first one stems from the continuity hypothesis (as

discussed in chapter 3) and states that people only watched black and white media at most for a few hours daily (and that is a very high estimate for the early 20th century), and the coloured reality was experienced far more often than the monochrome world of movies. Therefore, any influence the black and white media might have had should be minuscule when compared to coloured reality. This argument, combined with the numerous individual and social factors that could encourage greyscale dream reporting makes black and white media influence a remote possibility. The second objection emerges when the age-related differences in dream colour are presented – older people report more greyscale dreams than younger people, and people who had access to black and white media in their youth report more greyscale dreams than those without such access. This objection centres on the improbable longevity of the putative media influence. The people who are now reporting greyscale dreams have last had access to black and white media over 20 years ago, and in the meantime have been in constant contact with colour media. Even though the rates of greyscale dreaming have fallen between the 1950's (where around 90% of dreams were thought to be colourless) and now (where older people report having up to 30% of greyscale dreams), this is still a profound influence.

8.1.1 Evidence for the impact of media on dream colour

This thesis research yielded some support for the black and white media influence theory, and even though the results were not conclusive, the idea that media can have a fundamental impact on our mental imagery should now be entertained more seriously. Firstly, the present studies have provided evidence that age is not a factor in the reporting of greyscale dreams, and the actual access to black and white media before colour media strongly differentiates between people who dream mostly in colour and those who report greyscale dreams. Secondly, it has yielded further support by not finding any strong relationships

between visual memory and dream colour in the population that experiences more greyscale dreams. While a lack of results should always be taken cautiously, it does hint that the putative correlations are not very strong. Finally, the complex relationship between media experience and the recall quality of various dream colour types suggests that while the current young adults might indeed misreport their dreams as greyscale, the people who had had access to black and white media might indeed experience greyscale dreams.

Overall, the studies carried out for this thesis hint that media influence hypothesis is not as improbable as previously thought (Schwitzgebel, 2003). Therefore, some kind of an account is needed for why a few hours of monochrome movies would change the way people experience dreams, since the continuity hypothesis, introduced in chapter 4, does not have any explanation for this type of impact. The simplest way of explaining this would be to propose a sensitive period in the development of dreaming. There are a few cognitive abilities that have such a period when external influence can have a disproportionately strong impact on the development of that skill. Language is the most obvious example, but visual and spatial abilities also have such critical periods (Lewis and Maurer, 2005). Dreaming is a phenomenon that does not simply appear, but develops during childhood from simple and static images experienced around the age of 4-5 years to complex narrative constructions that fully mature in adolescence (Foulkes, 1999) and it is conceivable that there could be a critical period for the development of the visual form of dreaming. This proposition is a very strong one and would need to be meticulously researched before any degree of credibility is given to it. One way of testing this hypothesis would be to examine at what age the availability of black and white media had most impact. In the course of this thesis not enough people were tested to allow for such a comparison, but a wide scale survey could be a simple way of investigating this hypothesis.

8.2 Methodology of dream studies and memory for dream colour

The simplest explanation that has been proposed for the period of greyscale dream reports in the early 20th century is the methodological one. Together with what is known about memory impact on dream recall (as discussed in chapter 3), it provided a way to account for the widespread reports of greyscale dreams without postulating that greyscale dreaming actually happened. The key part of this argument rests on the convergence of the methodological breakthrough in dream research – discovery of REM sleep – and the simultaneous rise of coloured dreaming. The earlier studies tended to employ dream gathering methods that were prone to bias, while the REM awakenings method that was used by the studies that found that most of dreams contain colour is the most reliable way of obtaining dream reports.

8.2.1 Issues with the methodological explanation

The main problems with the methodological explanation is that it cannot, by itself, account for the history of greyscale dreaming. The first issue is the inability to explain why greyscale dream reports appeared in the early 20th century in the first place. The (admittedly non-scientific) enquiries into dream colour undertaken before the 20th century universally concluded that dreams are in colour, similarly to waking reality. While the introspective philosophical methods and the small sample sizes of the pre-20th century investigators do seem methodologically even less accurate than surveys and home dreams related to psychoanalysts, it would be hard to argue that greyscale dreams are reported only when the methodological accuracy hovers around medium levels. It is possible that people might have started reporting greyscale dreams due to the pressure from researchers, as some of the early studies on dream colour did suggest that coloured dreaming is an oddity. However, this only

moves the burden of explanation one step back, and it becomes necessary to account for why psychologists and researchers would suddenly start believing that dreams are devoid of colour, despite plentiful evidence for the contrary. This is even more puzzling taken that Freud and Jung believed that dreams are quite colourful while the psychoanalysts in the early 20th century seem to have completely forgotten about their founders remarks on dream colour. This issue can be resolved by postulating that the shift in reported dream colour was precipitated by a different factor – black and white media – and the imperfect methodology of the studies served to preserve and perhaps exacerbate the bias for interpreting dreams as greyscale.

The second issue the methodology explanation faces can also be solved when media impact is invoked. The problem lies in the inconsistency of the results of surveys and home dream recall across the 20th century. The first REM awakening studies resulted in a sharp increase in the proportion of coloured dreaming reported, but then the same research methods that used to yield greyscale dream reports (even identical questionnaires, as evidenced by Middleton 1942 and Schwitzgebel, 2003) started providing reports of mostly colour dreams in the second half of the 20th century. One explanation of this effect states that the results of the REM awakening studies were widely publicised and reversed the bias towards greyscale dreaming. While it seems unlikely that this type of research would actually become known across USA and Europe, it must be remembered that psychology students are the usual participants in such studies, and they are exactly the type of population who would have access to the new discoveries. A second explanation focuses on the influence of the researchers and posits that knowing that dreams should be reported in colour, they subtly encouraged their participants to do so. However, the simplest way of accounting for why questionnaires suddenly started yielding is through invoking the influence of the introduction

of coloured media, which shifted people's beliefs regarding how dreams can look like and removing the bias for reporting greyscale dreaming.

8.2.2 Evidence for the methodological explanation

The research carried out for this thesis has not provided any strong evidence for a purely methodological explanation of greyscale dream reports. Admittedly, because REM awakenings were not available, the comparisons could only be made between questionnaire and dream journal estimates of dream colour. Two studies explicitly compared the reports provided through a dream diary and a questionnaire and found that while there were some differences in the frequency of dream types obtained, they were most likely a product of the design of the particular instruments rather than a systematic difference between the more recent and less recent dreaming accounts. One such feature was the presence or absence of 'I don't know' option as a potential answer about the colour of dreams in questionnaires, another was the dream sample size for the journals. It would be informative to conduct a more detailed exploration of the early 20th century studies to see whether the structure of the questionnaires used might have encouraged people to report greyscale dreams. Moreover, when the impact of memory for colour on dream colouration was examined, it turned out that individual differences in memory and individual error patterns were related to both diary and questionnaire results and the effects were similar in magnitude. This means that the data obtained through the dream diary did not have a special status in terms of the memory interferences. While the lack of a comparison to dreams obtained from REM awakenings is problematic, it has been argued that home recall dreams are equivalent (Domhoff, 2003) to dreams gathered in a sleep laboratory Thus, it would be interesting to see if memory ability (and visual memory in particular) is also linked to dream colour in those dreams.

8.3 Visual imagery preferences and the form of dreams

In the field of dream studies there are currently two strands of research on the individual differences in dreaming. The first one investigates the relationship between various cognitive and personality skills and dream recall frequency (Schredl and Montasser, 1996-1997) and the second one looks at how personality and sex influences dream content (Hartmann, Rosen and Rand, 1998; Lang and O'Connor, 1984; Lumley and Bazydlo, 2000). There is, surprisingly, no research regarding the impact of cognitive abilities and preferences on the dream form – or the visual content. Visual imagery abilities and preferences would seem to be the foremost candidates for such research, since dreams are usually very visual in nature. Thus, the investigation of how visual imagery impacts the colour and content of dreams was one of the main novel points of this thesis. The present research is particularly interesting because it can serve as a starting point for the introduction of an interesting idea about the visual nature of dreams.

8.3.1 Dreams as incomplete visual simulations

The above mentioned lack of investigation into the effects of cognitive abilities on dream form might stem from the implicit 'movie' approach to dreaming, which assumes that dreams are 'presented' to the dreamer as full simulations of reality. These simulations might sometimes be bizarre and remote from waking reality, but they are nonetheless complete and pictorial, like a surrealist movie or painting. Thus, the idea that cognitive preferences might play a role in how this reality simulation is constructed has not appeared anywhere is dream literature.

However, the claim that dream reality is a warped copy of the waking visual world does not find support in the research on perception and imagery. They key issue is that people

overestimate how much they actually perceive – studies of visual consciousness have demonstrated that the seemingly complete and detailed visual field is to a large extent an illusion, and our conscious experience of seeing everything at once is simulated. In change blindness research, people fail to see the changes in a prominent element of an image when the changes are separated by a flash (Simons, 2000; Rensink and Simons, 2005) until their eyes stumble upon the relevant element of the picture – before they do that, the image is perceived as static. This phenomenon demonstrates that the mental representations that are created when we scan a picture are not complete or long lived enough to allow us to pick up on the change. All of us experience colours that have no physical basis for existence, since the peripheral vision does not allow for full colour discrimination – colour perception deteriorates with distance from fovea to dichromatic and finally monochromatic vision (Moreland and Cruz, 1959). And yet, we are not aware of not perceiving any colours in our visual periphery. What is 'added' is not necessarily a 'pixel by pixel' simulation of the visual field, since that would be resource consuming and ineffective; after all, it is enough to move the eyes to gather all the necessary data from the environment. What is constructed instead is a 'feeling of knowing' (Dennett, 1991).

Dreams are most probably created in the same way, not as full and detailed renderings of the imagined scenes (like in a computer simulation) but as a symbolic representation driven by the cognitive style of the dreamer and her attentional demands. Consequently, it is very likely that dream visual experiences are defined by the cognitive preferences and capabilities of the dreamer, not just through determining what is attended to and recalled within the dream world (which might be called the 'Virtual Reality' approach to dreaming) but by influencing what is actually generated. Visual imagery preferences are of particular importance here because they capture how an individual perceives and interacts with the visual world – and

because there is continuity in cognitive processes between waking and dreaming consciousness (Cicogna, Cavalerro and Bosinelli, 1991; Kahan and LaBerge, 1996) it is very likely that these imagery preferences also impact the visual experience of dreaming.

This notion is compelling because it integrates the studies of perception and imagery with dreaming and visual consciousness. The idea that only the salient and necessary elements of the dream visual environment are generated is parsimonious – however, it is as difficult to test as the achromatic dreaming theory which has been introduces in chapter 1. It is, in fact, a somewhat modified version of that approach, but instead of focusing on colour as the feature that dreams (for some reason) do not posses, it claims that what is 'missing' is dependent on the individual's cognitive abilities and preferences. However, because it is so difficult to disentangle the effects that might be caused by the posited generation processes and by simple memory and attention biases (which are also influenced by cognitive factors), finding evidence for this theory is a difficult task. What is needed is a demonstration of how dream visual content found in dream reports is related to cognitive preferences and at the same time not influenced by any visual memory measures.

8.3.2 Evidence for the incomplete simulation theory

The research carried out for this thesis provided some preliminary support for the completely novel idea of dreams as incomplete visual simulations (which will be henceforth called IST). Firstly, a consistent expected relationship was found between imagery preferences and dream colour as reported in the questionnaire and dream journal. Additionally, some tentative evidence for the relationship between imagery style and dream visual content was found in studies 4 and 6. Secondly, within the studies that looked at the issue visual imagery preferences were consistently not correlated with memory for visual

details. While memory measures had an effect on dream colour, they were not related to the dream visual content, even though they were factors in video clip descriptions in study 7. This is important because if the visual imagery measures used in this study were correlated with visual memory it could mean that any effects of imagery preferences on dream detail are mediated by memory abilities.

8.3.3 Alternative explanation

The evidence gathered for the ITS is, however, not as straightforward as the initial assessment would show. The strongest correlations between visual imagery and dream content were detected in dreams that were not written down immediately after awakening, but instead reported a few days after they were experienced, using the most recent dream method (study 4). The more recent reports or studies that used a dream diary to gather reports did not find any (or found confounding) evidence for the impact of imagery preferences on dream content, despite comparable sample sizes. This pattern indicates that the imagery preferences might not be influencing the dream generation process, but instead are subtly molding the dream narrative over time to fit into the cognitive expectations of visual or spatial detail. The dream narrative as reported after awakening contains all of the relevant details, and as time passes the dreamer selectively forgets the elements that are cognitively less important and reinforces the parts that are most salient for her. Because the details reported in the older and more recent dreams were comparable, it can be concluded that this process is not a result of memory degradation, but rather reflects the adjusting of dream report content (and presumably memory) to imagery preferences.

While this explanation is not as flashy as the IST, it is at the same time much more interesting from a practical point of view because it holds important consequences for the

methodology of dream research. As it was discussed in chapter 5, the current consensus is that the dreams collected through the most recent dream method are practically equivalent to morning reports. However, if the content of dream reports does shift with time, the similarities between the two sources of dream reports might be overestimated. Thus, the most recent dream form might not be the most reliable source of data when the investigation concerns the dream features that can be influenced by cognitive preferences such as imagery style. This is a major point, since the most recent dream paradigm has been touted as a highly reliable way of obtaining representative dream reports that match the standards of reports gathered through REM awakenings (Domhoff, 2003). Currently, more studies focused on the changes in dream reports in time are necessary to fully support this hypothesis. Firstly, if would be useful to see whether this effect can be found between individual dream reports, perhaps by asking participants to provide both a most recent dream report and a morning dream journal to compare the visual contents of both. So far, this thesis only demonstrated the memory shift across studies and considering the relatively small sample sizes used it is still possible that the effect is an artefact of the sample composition. For example, it is possible that the people who provided older dream reports did so because they recall overall fewer dreams, and thus the difference in the impact of imagery style might be connected with recall frequency rather than the time between the dream experience and report. Secondly, it would also be useful to ask people to provide a morning dream report and then ask them to re-report that dream after a time delay ranging from one day to a week to see if the effect can be detected within the same dream narrative. What is most interesting in this line of investigation is that it overlaps with more general research on episodic memory. If this detail shift operates within dream reports, it might also be present for other episodic memories. The last study suggested that reports from a short movie written down 15 minutes after watching the video clip are not influenced by

imagery preferences. Thus, it would be interesting to see whether the description of an episode (either experienced in life or through gameplay, or viewed) would shift with time to suit cognitive preferences.

8.4 Evaluation of the three theories of dream colour

In the introduction, three overarching ideas on how dream colour might work were presented. While they were not directly pursued throughout this thesis, they served as a framework of the investigation, providing ideas for examination along with a theoretical background. The Immutable Dreams theory posited that dreams have always been experienced in colour and any reports of greyscale dreams are a result of memory problems and external pressure. The Dream Shift theory claimed that people did actually experience greyscale dream in the early 20th century and that dream colour is malleable across time and individuals. Finally, the Achromatic Dreams theory stated that colour is not a property of dreams but instead is attributed to dream memories on awakening. While the last option is largely an untestable position, the first two approaches are able to provide a concrete set of predictions regarding reported dream colour and the factors that should influence it. The dream shift theory predicted that neither memory abilities nor methodological approaches should have a strong impact on reported dream colour, and instead access to black and white media and visual imagery preferences should be the key factors. The dream immutability approach, on the other hand, predicted that the way in which the dream reports are gathered and the individual abilities in memory should be the definite reasons behind greyscale dreaming reports. While this theory did acknowledge the possibility that media could have shaped dream reports, it limited this influence to people's beliefs and reports only – as

opposed to the dream shift approach which stated that black and white media genuinely changed dream colour.

The research carried out for this thesis did not manage to provide decisive evidence for any of the above-mentioned theories. As it was mentioned already, the Achromatic Dreaming approach did not manage to provide useful predictions due to its untestable nature and was thus only considered as conceptual background for the studies. The two other theories were, however to some extent tested. The methodological arguments for the Dream Immutability theory were somewhat weakened when the literature regarding the accuracy of home journal and questionnaire data was reviewed in chapter 3. The research findings regarding the differences between questionnaire and diary estimates obtained during this thesis were inconclusive, as the individual instrument characteristics seemed more important in shaping reported dream colour than the type of the instrument. The memory-related predictions of this hypothesis were, however, corroborated in that individual differences in visual memory were related to the reporting of coloured and greyscale dreaming. The findings of the third and seventh study thus provided support for the idea that greyscale dreams are an artefact of poor colour or visual memory, thus strengthening the Dream Immutability theory. These findings mesh with the Schredl et al. (2008) study, which found that reports of colourless dreams in a young population decline when they are asked for the presence of colour in dreams immediately after awakening.

At the same time, the very same studies that bolstered the idea that people have only colour dreams also found that visual imagery style is related to reported dream colour – which is an argument for the Dream Shift approach. The key point of this finding is that if we discover individual differences in dream colour that are linked to factors other than memory, it might mean that colourless dreams are possible and within the normal variability of human

experience. The second argument for the support of Dream Shift came from the first study, which found that dream recall quality for greyscale and colour dreams was the same in people who had regular access to black and white media in childhood, but not in those who had no such access. This result suggests that reports of greyscale dreams might have different causes in different populations. Among the older adults in the UK and some middle aged adults in central Europe the greyscale dreams might be a genuine effect of black and white media influence. In the populations that never had any significant access to black and white media, greyscale dreaming might be an effect of poor memory complicated by longer times between dream experience and recall. Because it was not feasible to carry out a follow up study in this thesis research, a larger project that would explicitly compare the effects of colour memory, timing of dream recall and media access on dream colour is necessary before any strong conclusions are made. If this result is replicated, the Dream Immutability theory will be considerably weakened, since all of the studies that have been carried out on the impact of visual memory on dream colour have used a very young population with no history of black and white media access.

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APPENDICES

Appendix 1: Dream colour questionnaire (Study 1)

1. How frequently do you dream?
   - □ Always
   - □ Very frequently
   - □ Frequently
   - □ Occasionally
   - □ Rarely
   - □ Never

2. Do you dream in colour or black and white?
   - □ Colour
   - □ Black and white
   - □ Both
   - □ Neither
   - □ Don't know

3. Do you have lucid dreams? (dreams in which you realise you're dreaming and can control the dream)
   - □ Very frequently
   - □ Frequently
   - □ Occasionally
   - □ Rarely
   - □ Never

4. At what age did you first have frequent access (at least once a month) to black and white media (TV or movies?)
   - □ 0-3 years old
   - □ 4-6 years old
   - □ 7-10 years old
   - □ 11-14 years old
   - □ 15 years or older
   - □ Never

5. At what age did you first have frequent access (at least once a month) to coloured media (TV or movies?)
   - □ 0-3 years old
   - □ 4-6 years old
   - □ 7-10 years old
   - □ 11-14 years old
   - □ 15 years or older
   - □ Never

6. How many hours per week do you watch TV or movies?
   - □ 0-1 hours
   - □ 2-5 hours
   - □ 5-10 hours
   - □ 11 hours or more

7. What percentage of the TV and movies you watch is in black and white (as opposed to colour)?
   - □ 0-20 %
   - □ 21-40%
   - □ 41-60%
   - □ 61-80%
   - □ 81-100%

Appendix 2: Dream diary instructions and sample page (Study 1)

Instruction

This diary is a tool for measuring dream recall frequency. You will be asked to fill out one sheet from this diary every morning after awakening. Although this can get tedious, and it's easy to forget about this in the morning, please try your best to fill out one page every day. A night after which you cannot remember any dreams is just as important as one with them. However, if due to some circumstances you skip a day, please tell me about it in the diary.

The heading:

You have to write the date, the amount of time that passed from your awakening, the number of times you have woken during the night and mark how many dreams you have managed to remember. Night awakening is defined here as any period during the night when you were sufficiently awake to recognise it, no matter how brief it is. Do not worry about the completeness of your dream memories – even if you remember only a few blurred images or impressions, you can mark these as dreams. If you have doubts whether the things you remember were a part of a single dream or many, use the 'don't remember how many dreams I had' option and use a single column thereafter. If you don't remember any dreams, mark '0' and skip the rest of the page. If (as it sometimes happens) you know you had dreams, but you can't remember anything about them, cross the number of dreams you had and put down "1" in all the subsequent fields.

The table:

This table has two parts. The first gauges the completeness of your dream recall, and the second asks you about the visual details from the dream. The first column contains the questions you have to answer for every dream you remember. They tap into the elements of the dream that you may remember in different ways. The answers should be put into the columns, each column for one dream. Thus, if you remember two dreams, you will use two columns. Now, we will go over the questions to explain them.

The scoring system:

1 – not at all 2 – vaguely 3 – moderately 4 – quite well 5 - perfectly

A 'perfect' rating means that your memory of the dream element is just as good as of any waking-life event you recently experienced.

1. How well can you remember characters?

This is about everyone you 'met' in the dream, human and non-human alike. Do you remember the number of key characters? Who they were? How they looked like? What they did?

2. How well do you remember the setting?

Most dream action takes place somewhere – that place can be known to you or totally new. Can you remember if it was familiar or unfamiliar, indoors or outdoors, dynamic or static?

3. How well can you remember the plot?

Apart from your actions and dream characters, most dreams have some sort of a plot, however absurd. Do you feel you remember enough of the dream to still understand it or is it all fragmented?

4. How well can you remember your actions?

This part asks about what you remember about your dreaming self. Who you were in that dream? What did you do? What were the reasons and outcomes of your actions?

5. Was it a lucid dream? (Yes/No)

A lucid dream is defined as a dream in which the dreamer realises that he/she is dreaming. This realisation is qualitatively different from simply 'dreaming about dreaming' or 'dreaming about waking up'. Being in a state of lucid dreaming often enables the dreamer to influence the content of the dream or to wake up from it.

6. How well can you remember the visual scenes?

This concerns all the visual scenes that you remember seeing in the dream. Are they vivid and clear or are they just foggy, fragmented images? Can you remember the dream like a movie, or are there just a couple of 'stills' in your memory?

7. Do you remember seeing any colours in the dream? (Yes/No/ N/A)

This question refers to you memory of any colours in the dream. Answer yes if you are sure there have been some coloured elements in your dream.

8. Was this dream entirely in colour? (Yes/No/ N/A)

Answer yes if you are quite sure that the whole visual content of your dream was in colour.

9. If yes, were the colours life-like? (Yes/No/ N/A)

Colours in a dream can be very different from what ordinary, waking life looks like. The whole dream can have a predominant colour (i.e. everything looks green), or it's just some elements that can have odd colours (i.e. blue trees).

10. If your dream had any colours, rate the vividness. (On a scale from A to D)
Colours in a dream can appear faded and pale or they can be extremely vivid. Treat A as 'more vivid than in waking life', B as 'just as vivid as in waking life', C as 'paler than in waking life' and D as 'much paler than in waking life'.

11. Was this dream in black and white? (Yes/No/ N/A)
A dream can be totally devoid of any colour, and present itself in various shades of black, white and grey. If that is the case in your dream, answer yes.

12. Has the dream been a mix of colour and black and white? (Yes/No/ N/A)
In some dreams, one coloured object can stand out from a grey background. Or some parts are grey (when they shouldn't be – i.e. grey trees). Has your dream looked like that?

13. Have the colours changed throughout the dream? (Yes/No/ N/A)
Sometimes a dream can switch from colour to greyscale or the other way around, or the colour scheme can change. Has that happened in your dream?

Dream Recall Diary sample page

Date:…… Time after awakening:……

Number of night awakenings 0 1-2 3-4 more than 4 don't know

Number of dreams remembered: 0 1 2 3 4 more than 4
Don't remember / Don't know how many dreams I've had

Please fill out the following table. Use a separate column for each of the dreams you had, and if you're not sure how many dreams you've had, use one column to summarise what you remember about your dream(s). In the columns, please rate how well you remember each aspect of the dream. Some questions require only a yes/no answer, and one question requires you to rate the vividness of colours on a separate scale. The rating systems are given below:

Rating system for questions 1-4 and 6

1 – not at all *2 – vaguely* *3 – moderately* *4 – quite well* *5 – perfectly*

Rating system for question 10

A – very vivid *B – life-like* *C – faded* *D – very faded*

If you don't remember enough from the dream to answer a question, or that particular question does not apply to your dream, please mark N/A in the appropriate box.
If you have any comments about the colour experiences in your dream, feel free to put them on the bottom or on the reverse of the page.

Q		***Dream 1***	***Dream 2***	***Dream 3***	***Dream 4***
1	How well do you remember characters? (On a scale from 1 to 5)				
2	How well do you remember the setting? (On a scale from 1 to 5)				
3	How well do you remember the plot? (On a scale from 1 to 5)				
4	How well do you remember your actions? (On a scale from 1 to 5)				
5	Was it a lucid dream? (Yes/No/ N/A)				
6	How well do you remember visual scenes? (On a scale from 1 to 5)				
7	Do you remember seeing any colours in the dream? (Yes/No/ N/A)				
8	Was this dream entirely in colour? (Yes/No/ N/A)				
9	If yes, were the colours life-like? (Yes/No/ N/A)				
10	If your dream had any colours, rate the vividness. (On a scale from A to D)				
11	Was this dream in black and white? (Yes/No/ N/A)				
12	Has the dream been a mix of colour and black and white? (Yes/No/				

	N/A)				
13	Have the colours changed throughout the dream? (Yes/No/ N/A)				

Appendix 3: Dream attitude scale (Study 1)

Below, you will be presented with 8 statements about dreams and dreaming. You will be required to express whether you agree or disagree with each of these statements on a provided scale. To answer, circle the response that represents your feelings, opinions and actions the best.

1. I feel excited after dreaming

Strongly agree	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*

2. I often spend some time trying to recall my dreams

Strongly agree	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*

3. I can talk about dreams for hours.

Strongly agree	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*

4. Dreaming is fun

Strongly agree	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*

5. Dreams can offer insight into oneself.

Strongly agree	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*

6. Dreams are too far away from reality to be of any importance

Strongly agree	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*

7. Dreaming is a waste of time

Strongly agree	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*

8. I pay no attention to my dreams

Strongly agree	*Agree*	*Undecided*	*Disagree*	*Strongly disagree*

Appendix 4: Items from the dream colour questionnaire (Study 2)

1. Age?
2. Sex? M/F
3. At what age did you first gain regular (at least once a month) access to black and white movies?
4. At what age did you first gain regular (at least once a month) access to black and white television?
5. At what age did you first gain regular (at least once a month) access to colour movies?
6. At what age did you first gain regular (at least once a month) access to colour television?

7. Do you experience coloured dreams? Y/N

7.1 How certain are you of this?

1 2 3 4 5 6 7

I'm guessing *I'm completely sure*

7.2 What percentage of your dreams is coloured?

7.3 Can you, at the moment, remember any coloured dream you've had? Y/N

8. Do you experience black and white dreams? Y/N

8.1 How certain are you of this?

1 2 3 4 5 6 7

I'm guessing *I'm completely sure*

8.2 What percentage of your dreams is black and white?

8.3 Can you, at the moment, remember any black and white dream you've had? Y/N

9. Do you experience dreams that are a mix of colour and black and white? Y/N

9.1 How certain are you of this?

1 2 3 4 5 6 7

I'm guessing *I'm completely sure*

9.2 What percentage of your dreams is such a mix?

9.3 Can you, at the moment, remember any mixed dream you've had? Y/N

Appendix 5: Example pictures used in the colour memory task (Study 3)

Appendix 6: Colour Imagery Task items (Study 3)

Which is more	Items to compare		
Red	Strawberry	or	Raspberry
	Ketchup	or	Radish
	Orange	or	Carrot
	Butternut squash	or	Carrot
	Cherry	or	Beetroot
	Red currant	or	Raspberry
Yellow	Olive	or	Green pepper
	Raw potato	or	Pineapple
	Custard	or	Rice pudding
	Corn	or	Porridge
	Raw potato	or	Cauliflower
Green	Granny Smith apple	or	Golden delicious apple
	Lettuce	or	Parsley
	Cucumber flesh	or	Pistachio
	Spinach	or	Lettuce
White	Custard	or	Mayonnaise
	Milk	or	Mushroom
	Egg white	or	Cauliflower
	Coconut flesh	or	Cauliflower
	Porridge	or	Salt
Dark	Penny coin	or	Pound coin
	Green pepper	or	Courgette skin
Semantic items			
Worth	Pound coin	or	Penny coin
Fruit	Apple	or	Beetroot
Vegetable	Mayonnaise	or	Courgette
Edible	Plaster	or	Rice pudding
Sweet	Banana	or	Lemon

Appendix 7: Rating scale and items from the Object-Spatial Imagery Questionnaire

1	*2*	*3*	*4*	*5*
Totally disagree	*Disagree*	*Unsure*	*Agree*	*Totally agree*

1. I was very good in 3-D geometry as a student.
2. If I were asked to choose between engineering professions and visual arts, I would prefer engineering.
3. Architecture interests me more than painting.
4. My images are very colourful and bright.
5. I prefer schematic diagrams and sketches when reading a textbook instead of colourful and pictorial illustrations.
6. My images are more like schematic representations of things and events rather than detailed pictures.
7. When reading fiction, I usually form a clear and detailed mental picture of a scene or room that has been described.
8. I have a photographic memory.
9. I can easily imagine and mentally rotate 3-dimensional geometric figures.
10. When entering a familiar store to get a specific item, I can easily picture the exact location of the target item, the shelf it stands on, how it is arranged and the surrounding articles.
11. I normally do not experience many spontaneous vivid images; I use my mental imagery mostly when attempting to solve some problems like the ones in mathematics.
12. My images are very vivid and photographic.
13. I can easily sketch a blueprint for a building that I am familiar with.
14. I am a good Tetris player.
15. If I were asked to choose between studying architecture and visual arts, I would choose visual arts.
16. My mental images of different objects very much resemble the size, shape and colour of actual objects that I have seen.
17. When I imagine the face of a friend, I have a perfectly clear and bright image.

18. I have excellent abilities in technical graphics.
19. I can easily remember a great deal of visual details that someone else might never notice. For example, I would just automatically take some things in, like what colour is a shirt someone wears or what colour are his/her shoes.
20. In high school, I had less difficulty with geometry than with art.
21. I enjoy pictures with bright colours and unusual shapes like the ones in modern art.
22. Sometimes my images are so vivid and persistent that it is difficult to ignore them.
23. When thinking about an abstract concept (e.g. ‘a building’) I imagine an abstract schematic building in my mind or its blueprint rather than a specific concrete building.
24. My images are more schematic than colourful and pictorial.
25. I can close my eyes and easily picture a scene that I have experienced.
26. I remember everything visually. I can recount what people wore to a dinner and I can talk about the way they sat and the way they looked probably in more detail than I could discuss what they said.
27. I find it difficult to imagine how a 3-dimensional geometric figure would exactly look like when rotated.
28. My visual images are in my head all the time. They are just right there.
29. My graphic abilities would make a career in architecture relatively easy for me.
30. When I hear a radio announcer or a DJ I’ve never actually seen, I usually find myself picturing what he or she might look like.

Appendix 8: Vividness of Visual Imagery Questionnaire (Study 3)

Visual imagery refers to the ability to visualize, that is, the ability to form mental pictures, or to "see in the mind's eye". Marked individual differences have been found in the strength and clarity of reported visual imagery and these differences are of considerable psychological interest.

The aim of this test is to determine the vividness of your visual imagery. The items of the test will possibly bring certain images to your mind. You are asked to rate the vividness of each image by reference to the 5-point scale given below. For example, if your image is "vague and dim" then give it a rating of 4. Before you turn to the items on the next page, familiarize yourself with the different categories on the rating scale. Throughout the test, refer to the rating scale when judging the vividness of each image. Try to do each item separately, independent of how you may have done other items.

Rating Scale

<u>The image aroused by an item might be:</u>

Perfectly clear and as vivid as normal vision …..... rating 1
Clear and reasonably vivid …..... rating 2
Moderately clear and vivid …..... .rating 3
Vague and dim …..... rating 4
No image at all, you only "know" that you are thinking of an object .. rating 5

.....

In answering items A to D, think of some relative or friend whom you frequently see (but who is not with you at present) and consider carefully the picture that comes before your mind's eye.

A The exact contour of face, head, shoulders and body.

B Characteristic poses of head, attitudes of body etc.

C The precise carriage, length of step, etc. in walking.

D The different colours worn in some familiar clothes.

.....

Visualise the rising sun. Consider carefully the picture that comes before your mind's eye.

E The sun is rising above the horizon into a hazy sky

F The sky clears and surrounds the sun with blueness

G Clouds. A storm blows up, with flashes of lightening

H A rainbow appears

.....

Think of the front of a shop which you often go to. Consider the picture that comes before your mind's eye.

I The overall appearance of the shop from the opposite side of the road

J A window display including colours, shape and details of individual items for sale.

K You are near the entrance. The colour, shape an details of the door.

L You enter the shop and go to the counter. The counter assistant serves you. Money changes hands.

.....

Finally, think of a country scene which involves trees, mountains and a lake. Consider the picture that comes before your mind's eye.

M The contours of the landscape

N The colour and shape of the trees

O The colour and shape of the lake

P A strong wind blows on the tree and on the lake causing waves

Appendix 9: Coded examples of two dreams (Study 4)

I was **walking down to the golf course** with my **clubs on my back**. I took the usual route down and **jumped over the wall** instead of having to walk all the way around. As I **walked through the car park** a couple of **older** men were **putting** their **clubs into the car** and another was **changing out of** his **golf shoes**. I **changed** my **shoes** and left them **in the drying room** instead of my locker. It was a warm day although the wind was strong so I kept my **jumper** on. I **opened** the **door** to the **Pro shop** asked the assistant, Stuart (22, male, good friend) if I could just play straight away. He was **watching** the **TV** and said the course was dead. I **walked onto the tee** and checked if there was anyone **a couple of holes in front**, there was no one so I knew it would be a quick round. I saw no one on the course until the **5th hole** when I noticed two greenkeepers working **on the adjacent 13th green**. One was **replacing** the **hole position** and Connel, a fellow junior member was **raking** a **bunker**. It was starting to get **dark** by the time I finished 9 holes and the **car park** only had the Secretary's **red car in it**. I **walked up the road**, the same route I walked down and **checked** my **phone** to see what the time was. When I got home, my brother, Wiliam was **standing in my room**. William is my younger brother. He was **going through** my **wardrobe** and kept asking if I had any old clothes for him. I said no continuously until he **pulled out** my **green polo shirt**. He was determined to get that top and I had to explain to him that I still wear it so there was no chance of him getting it. He went in a mood and **stormed out the room** and I went and **sat** down **at my desk**.

Word count: 334

Content word count: 329

Objects: 24

Visible actions: 18

Spatial details: 15

Visual details: 2

Colour details: 2

The setting was at a **church** which is familiar to me. I was **at the end of a corridor** and I could see my boyfriend **at the other end of it**. It made me happy to see him and I smiled and started to **quickly walk towards him** (for the purpose of the study my boyfriend is a 24 yr old male). He was **standing at the bottom of the steps** at the **door** at the end of the corridor. I was now **standing in** the **doorway** still smiling at him. He **glanced up at me** with a **half smile** then **looked to his right** (my left) rather **intensely**. I **peered around the corner** to see what he was looking at. In the dream, I was expecting him to be looking at something weird or funny or perhaps an argument between people we knew. I was devastated to see the girl he dated a year before we started going out. She was **leaning against the wall** and she was **smiling**. She then said 'Thanks for everything'. Then I woke up. I was devastated and it was very unpleasant.

Total word count: 188

Content word count: 155

Objects: 8

Visible actions: 8

Spatial details: 9

Visual details: 3

Colour details: 0

Appendix 10: Dream colour questionnaire (Study 4)

Please fill in or highlight your answers

What is you age?_____

What is your sex? Male / Female

What is your native language? _____

How soon after awakening did you usually write down your dreams that were placed on the dreamjournal pages?

- A few minutes after I wake up
- Up to an hour after I wake up
- Within 2-3 hours after I wake up
- Between 4-12 hours after I wake up
- More than 12 hours after I wake up
- I don't remember

At what age did you first gain regular (at least once a month) access to black and white movies? _____

At what age did you first gain regular (at least once a month) access to black and white television? _____

At what age did you first gain regular (at least once a month) access to colour movies?

At what age did you first gain regular (at least once a month) access to colour television? _____

Do you experience coloured dreams? Y / N

How certain are you of this?

1 2 3 4 5 6 7

I'm guessing *I'm completely sure*

What percentage of your dreams is coloured? _____

Can you, at the moment, remember any coloured dream you've had? Y / N

Do you experience black and white dreams? Y / N

How certain are you of this?

1 2 3 4 5 6 7

I'm guessing *I'm completely sure*

What percentage of your dreams is black and white? _____

Can you, at the moment, remember any black and white dream you've had? Y / N

Do you experience dreams that are a mix of colour and black and white? Y / N

How certain are you of this?

1 2 3 4 5 6 7

I'm guessing *I'm completely sure*

What percentage of your dreams is such a mix? _____

Can you, at the moment, remember any mixed dream you've had? Y / N

How often do you find yourself unable to recall anything about the presence (or absence) or colour in your dreams?

- ☐ Almost never
- ☐ Rarely
- ☐ Occasionally
- ☐ Often
- ☐ Very often
- ☐ Almost always

Appendix 11: Polish OSIQ items (Study 6)

1. Geometria przestrzenna nigdy nie sprawiała mi problemów w szkole. / Zawsze byłem bradzo dobry w gemoetrii przestrzennej
2. Gdybym miał wybierać pomiedzy zawodem inzyniera a plastyka, wybrałbym inzynierię.
3. Architektura interesuje mnie bardziej niż malarstwo.
4. Moje wyobrażenia wzrokowe są bardzo kolorowe i wyraźnie.
5. Kiedy czytam podręcznik, wolę schematyczne diagramy I szkice od kolorowych i obrazowych ilustracji.
6. Moje wyobrażenia wzrokowe bardziej przypominają schematyczne reprezentacje przedmiotów i wydarzeń niż szczegółowe obrazy.
7. Kiedy czytam literaturę, zwykle wyobrażam sobie wyraźny i szczegółowy obraz sceny lub pokoju opisanego w książce.
8. Mam fotograficzna pamięc.
9. Z łatwością wyobrażam sobie i manipuluję trójwymiarowymi figurami geometrycznymi.
10. Kiedy wchodzę do znajomego sklepu po coś konkretnego, mogę z łatwością wyobrazić sobie dokładną lokalizację tej rzeczy, półkę na której stoi, jak jest ułozona i z czym sąsiaduje.
11. Zwykle nie doświadczam wielu spontanicznych I wyraźnych wyobrażeń wzrokowych; używam wizualizacji głównie podczas rozwiązywania pewnych problemów, na przykład matematycznych.
12. Moje wyobrażenia wzrokowe są wyraziste I fotograficzne.
13. Mogę z łatwością naszkicować plan znanego mi budynku.
14. Jestem dobry w grze w Tetrisa.
15. Gdybym miał wybierać pomiędzy studiowaniem architektury I sztuk plastycznych, wybrałbym sztuki plastyczne.
16. Moje wyobrażenia wzrokowe różnych przedmiotów są bardzo podobne do tych przedmiotów jeśli chodzi o rozmiar, kształt i kolor.
17. Kiedy wyobrażam sobie twarz przyjaciela, widzę ją bardzo jasno I wyraźnie.

18. Mam doskonałe umiejętności w rysunku technicznym.
19. Z łatwością pamiętam dużą ilość wizualnych szczegółów, których inni ludzie rzadko zauważają. Pewne rzeczy rejestruje automatycznie, na przykład kolor czyjejś koszuli lub kolor jego/jej butów.
20. W szkole sredniej geometria sprawiała mi mniej kłopotów niż plastyka.
21. Lubię obrazy z jaskrawymi kolorami I niezwykłymi kształtami, jak te spotykane w sztuce współczesnej.
22. Czasami moje wyobrażenia wrokowe są tak wyraźne i trwałe, że trudno mi je zignorować.
23. Kiedy myśle o jakims abstrakcyjnym koncepcie (np. budynek), wyobrażam sobie abstrakcyjny schemat budynku, lub jego plan a nie jakiś konkretny budynek.
24. Moje wyobrażenia wzrokowe są bardziej schematyczne niż kolorowe i ilustracyjne.
25. Mogę zamknąc oczy i z łatwością wyobrazić sobię scenę, jakiej doświadczyłem.
26. Praktycznie wszystko pamiętam wzrokowo. Mogę przypomnieć sobie co ludzie mieli na sobie na spotkaniu i mogę opowiedzieć w jaki sposób siedzieli z większą dokładnością niż o tym, co mówili.
27. Z trudnością wyobrażam sobie jak dokładnie wyglądałaby trójwymiarowa figura geometryczna po obróceniu.
28. Moje wyobrażenia wzrokowe są My visual images are in my head all the time. They are just right there.
29. Moje umiejętności graficzne ułatwiły by mi karierę w architekturze.
30. Kiedy słyszę prezentera radiowego którego nigdy nie widziałem, zwykle wyobrażam sobie w jaki sposób on/ona mógłby wyglądać.

Appendix 12: Polish Dream colour questionnaire (Study 6)

Wiek _____

Płeć: Kobieta / Mężczyzna

W jakim wieku uzyskałeś regularny (przynajmniej raz na miesiąc) dostęp do czarno-białych filmów? _____

W jakim wieku uzyskałeś regularny (przynajmniej raz na miesiąc) dostęp do czarno-białej telewizji? _____

W jakim wieku uzyskałeś regularny (przynajmniej raz na miesiąc) dostęp do kolorowych filmów? _____

W jakim wieku uzyskałeś regularny (przynajmniej raz na miesiąc) dostęp do kolorowej telewizji? _____

Czy zdarzają ci się kolorowe sny? Tak / Nie

Jak bardzo jesteś tego pewny?

1	2	3	4	5	6	7
Zgaduję						*Jestem zupełnie pewny*

Oceń, jaki procent twoich snów jest kolorowy.

0% 1-10% 11-25% 26-50% 51-75% 75%-99% 100%

Czy jesteś w stanie sobie teraz przypomnieć jakiś sen, co do którego jestes pewien, że był kolorowy? Tak / Nie

Czy zdarzają ci się czarno-białe sny? Tak / Nie

Jak bardzo jesteś tego pewny?

1 2 3 4 5 6 7

Zgaduję *Jestem zupełnie pewny*

Oceń, jaki procent twoich snów jest czarno-biały.

0% 1-10% 11-25% 26-50% 51-75% 75%-99% 100%

Czy jesteś w stanie sobie teraz przypomnieć jakiś sen, co do którego jestes pewien, że był czarno-biały? Tak / Nie

Czy zdarzają ci się sny w których mieszają się kolory z czarno-białym? Tak / Nie

Jak bardzo jesteś tego pewny?

1 2 3 4 5 6 7

Zgaduję *Jestem zupełnie pewny*

Oceń, jaki procent twoich snów jest mieszanką koloru i czerni oraz bieli.

0% 1-10% 11-25% 26-50% 51-75% 75%-99% 100%

Czy jesteś w stanie sobie teraz przypomnieć jakiś sen, co do którego jestes pewien, że był taką mieszanką? Tak / Nie

31. Jak często zdarza ci się nie pamiętać obecności jakichkolwiek kolorów lub czerni i bieli w snach?

0% 1-10% 11-25% 26-50% 51-75% 75%-99% 100%

Appendix 13: Polish Most Recent Dream form (Study 6)

–

Wiek _____

Płeć _____

Data _____

Kiedy przyśnił się ten sen: _____.

Kiedy go sobie przypomniałeś/aś: _____.

Gdzie byłeś/aś kiedy przypomniałeś/aś sobie ten sen: _____.

Opisz swój ostatni sen najpełniej i najdokładniej jak potrafisz. Raport powinien zawierać, jeśli możliwe, opis scenerii snu, mejsc oraz obiektów widzianych we śnie a także opisy osób tam występujących. Pamiętaj, żeby opisac swoje uczucia oraz myśli, które przychodziły ci do głowy w trakcie snu. Upewnij się, że opisałeś wszystko co przydarzyło sie w trakcie snu tobie lub innym postaciom.

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Appendix 14: Gestalt Completion Test (Study 7)

Name _____

GESTALT COMPLETION TEST -- CS-1

This is a test of your ability to see a whole picture even though it is not completely drawn. You are to use your imagination to fill in the missing parts.

Look at each incomplete picture and try to see what it is. On the line under each picture, write a word or two to describe it.

Try the sample pictures below:

1. _____

2. _____

Picture 1 is a flag and picture 2 is a hammer head.

Your score on this test will be the number of pictures identified correctly. Even if you are not sure of the correct identification, it will be to your advantage to guess. Work as rapidly as you can without sacrificing accuracy.

You will have 2 minutes for each of the two parts of this test. Each part has two pages. When you have finished Part 1 (pages 2 and 3), STOP. Please do not go on to Part 2 until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO

Page 2

Part 1 (2 minutes)

1. _____

2. _____

3. _____

4. _____

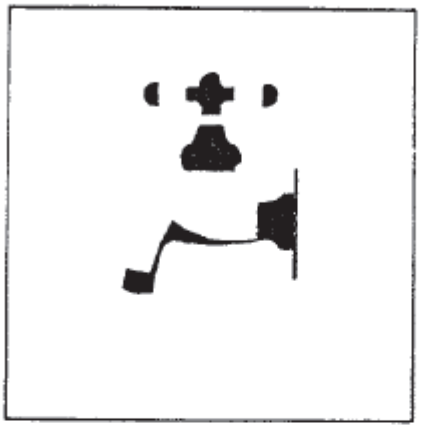
5. _____

6. _____

GO ON TO THE NEXT PAGE

Part 1 (continued)

7. _____



8. _____

9. _____

10. _____

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO. STOP.

Part 2 (2 minutes)

11. _____

12. _____

13. _____

14. _____

15. _____

16. _____

GO ON TO THE NEXT PAGE

Part 2 (continued)

17. _____

18. _____

19. _____

20. _____

DO NOT GO BACK TO PART 1 AND
DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO.

STOP.

Appendix 15: Snowy Pictures Test (Study 7)

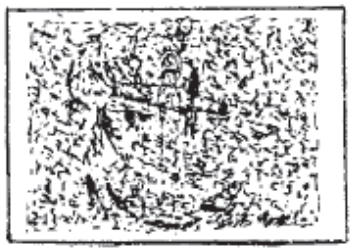
Name _____

SNOWY PICTURES -- CS-3

It is helpful to be able to see objects quickly in spite of their being partially concealed by snow, rain, haze, darkness, or other visual obstructions. In this test you will be asked to recognize hard-to-see objects.

Look at the picture below. What object do you see?

Sample Item 1:

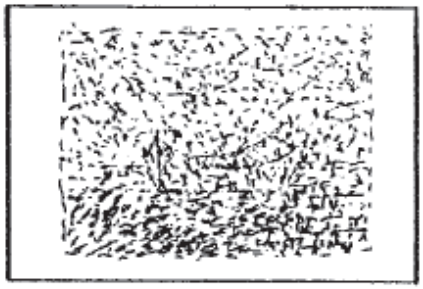


1. anchor

By looking carefully at this sample you will see an anchor. The word anchor has been written on the line under the picture.

Now try another sample. Write the name of the object on the line provided.

Sample Item 2:



2. _____

The picture shows a small boat sitting in the water. Boat, rowboat, or other similar words would be correct answers.

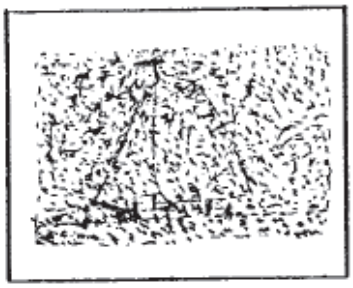
Your score on this test will be the number of objects that you name correctly. Work as quickly as you can without sacrificing accuracy. If some pictures are difficult, skip them and return to them later if you have time.

You will have 3 minutes for each of the two parts of this test. Each part has one page with 12 objects to identify. When you have finished Part 1, STOP. Do not go on to Part 2 until asked to do so.

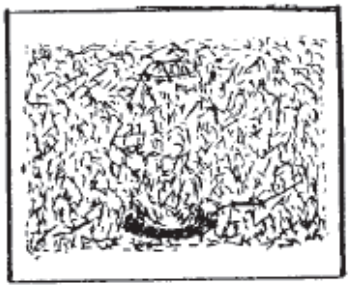
DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Part 1 (3 minutes)

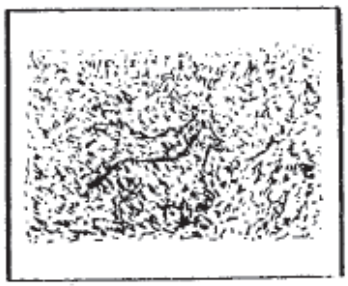
Write one or two words to describe each picture.



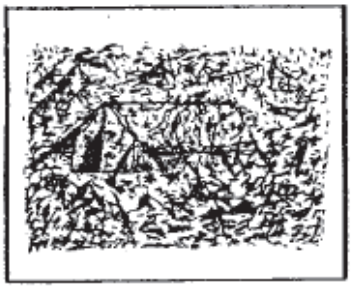
1. _____



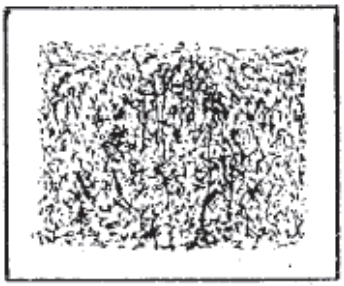
2. _____



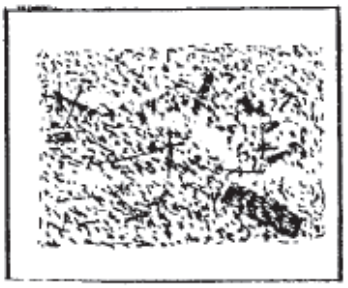
3. _____



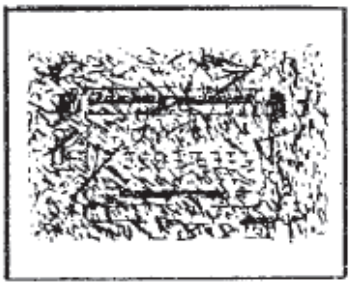
4. _____



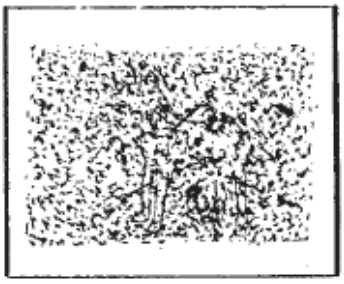
5. _____



6. _____

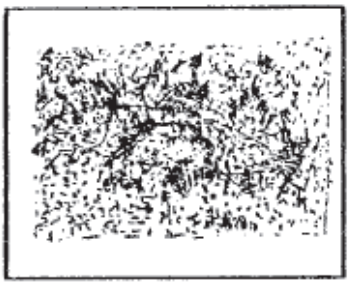


7. _____



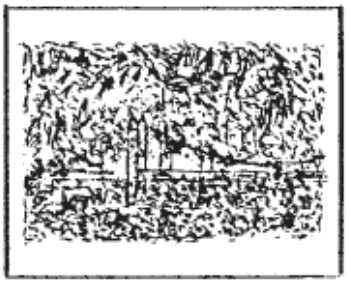
8. _____

9. _____



10. _____

11. _____



12. _____

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO

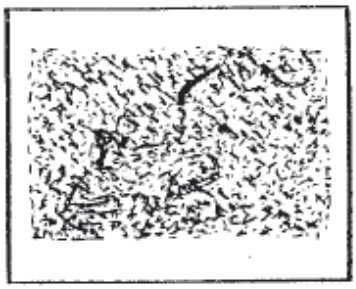
STOP.

Page 3

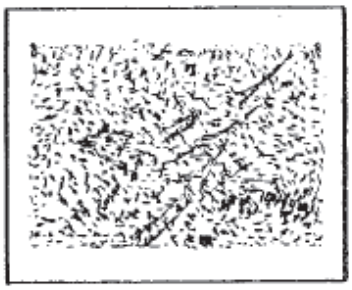
Part 2 (3 minutes)

Write one or two words to describe each picture.

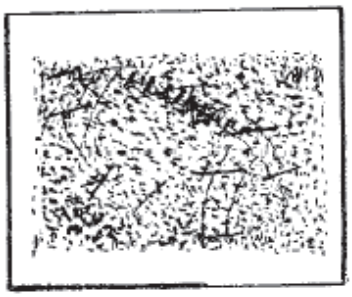
13. _____



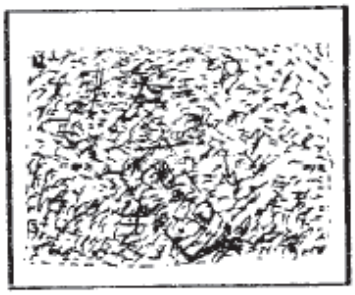
14. _____



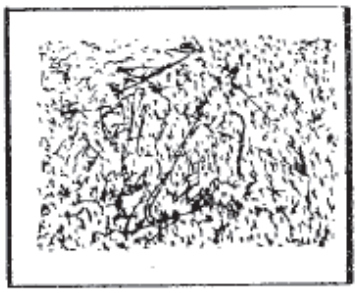
15. _____



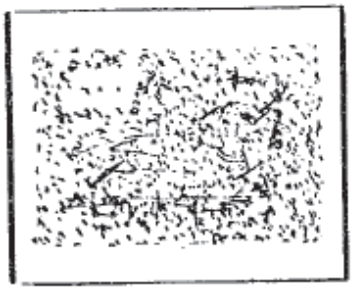
16. _____



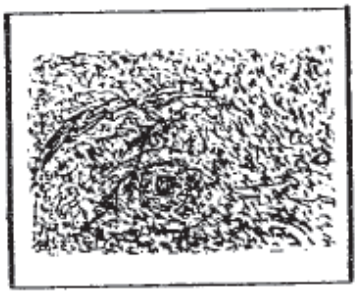
17. _____



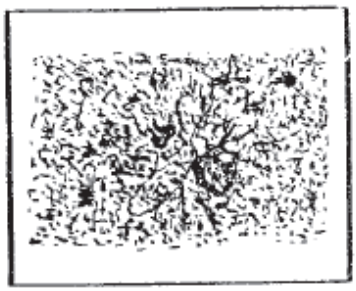
18. _____



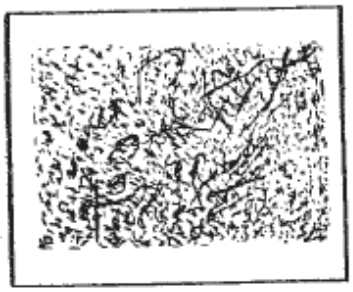
19. _____



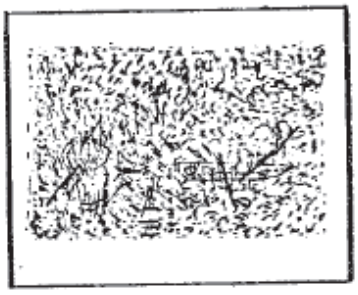
20. _____



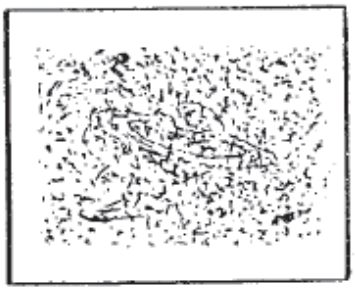
21. _____



22. _____



23. _____



24. _____

DO NOT GO BACK TO PART 1 AND
DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO.

STOP.

Appendix 16: Dream diary (Study 7)

Instruction:

This diary is a tool for recording your dreams. You will fill out one sheet from this diary for every dream you remember. You will fill this diary out for 7 days or until you run out of sheets. You do not have to fill the diary completely during the 7 days – people's dream recall frequency varies greatly and even a few dream records are valuable data for the study.

The heading:

You have to write down the date and the amount of time that passed since your awakening – so if you woke up at 8am and you are filling the diary at 8.30am, you should write 30 minutes. It is important that you try to record your dreams as soon after awakening as possible, since they tend to fade quickly.

The dream report:

Here you are asked to write down your dream. Please describe the dream exactly and as fully as you remember it. Be sure to tell exactly what happened during the dream to you and the other characters. Your report should contain, whenever possible: a description of the setting of the dream, and a description of the characters in the dream.

The table:

Do you remember any particular colour elements from this dream? (Yes/No/ Don't remember)

This question refers to your memory of any colours in the dream. Answer yes if you are sure there have been any coloured elements in your dream. Please note what they were in the space provided below the question.

Was the whole dream in colour? (Yes/No/ Don't remember)

Answer yes if you are quite sure that the whole visual content of your dream was in colour.

Can you remember any black and white elements? (Yes/No/ Don't remember)

This question refers to your memory of any black and white elements in the dream. This concerns objects that would normally have colour, but appeared as black and white, or greyscale, in the dream. Thus, for example, a zebra would not count, while a greyscale lion would. Answer yes if you are sure there have been any greyscale elements in your dream. Please note what they were in the space provided below the question.

Was the dream completely in black and white? (Yes/No/ Don't remember)

A dream can be totally devoid of any colour, and present itself in various shades of black, white and grey. If that is the case in your dream, answer yes.

Dream 1

Date:……

Time since waking up……..

Please write down your dream below. If you run out of space, continue on a separate sheet.

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Please answer the following questions:

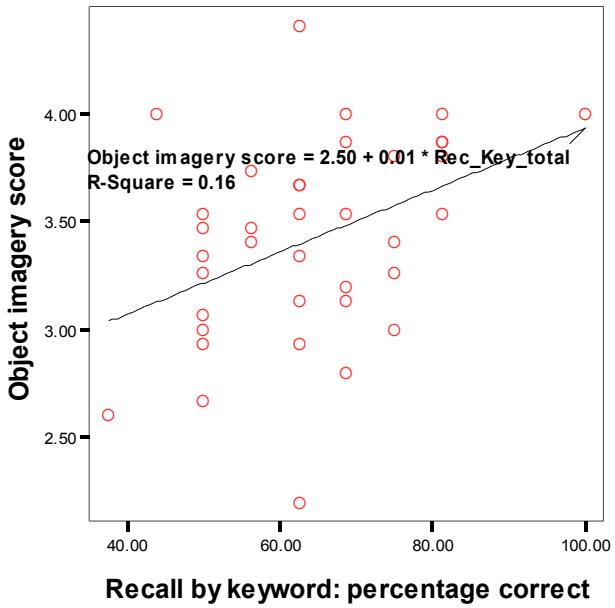
Do you remember any particular colour elements from this dream?	
If yes, please write down what it was:	
Was the whole dream in colour?	
Do you remember any black and white elements?	
If yes, please write down what it was:	
Was the dream completely in black and white?	

Appendix 17: Video clip description (Study 7)

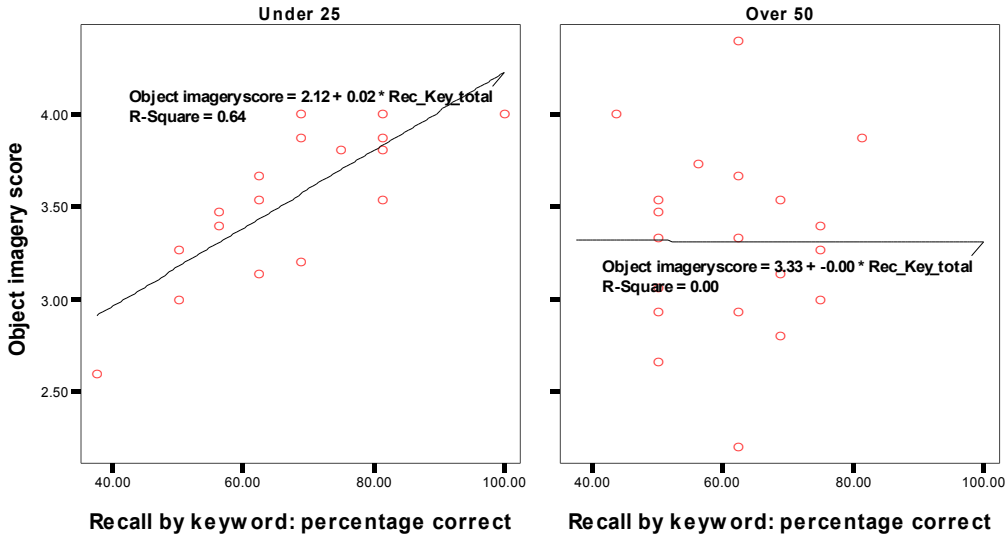
Please describe the clip you have just seen as fully as you remember it. Your report should contain a description of the setting of the action and a description of the people who appeared in the movie. Be sure to tell exactly what happened to the characters during the movie.

Appendix 18: Scatterplots for Experiment 3

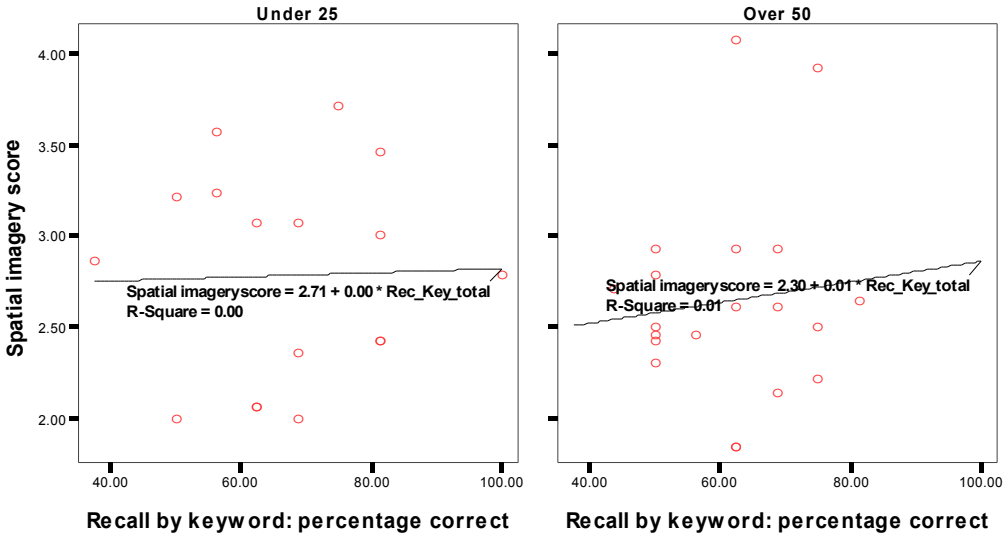
1) Object Imagery and colour recall task scores for the whole group (Section 6.3.37)



2) Age differences in how Object Imagery score relates to colour recall task scores (Section 6.3.37)

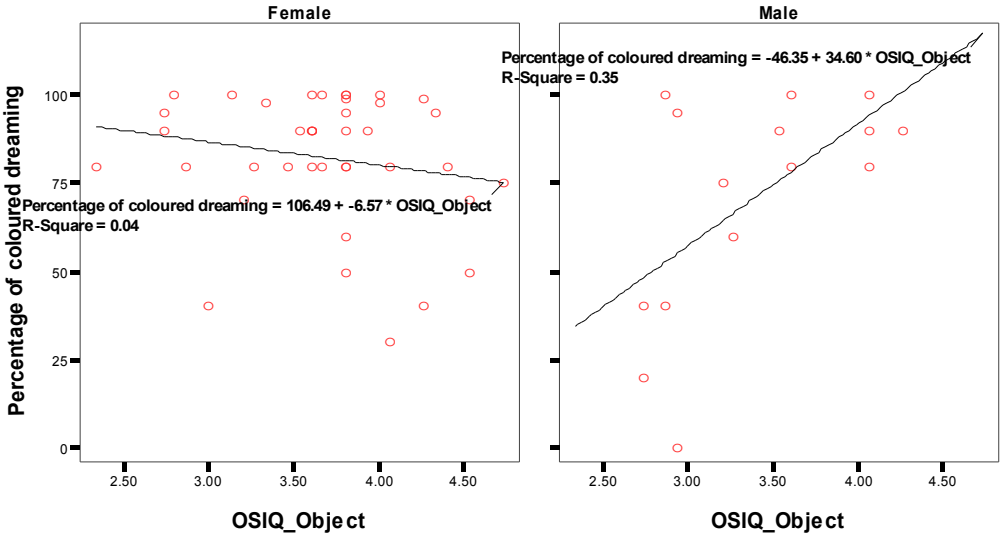


3) Age differences in how Spatial Imagery score relates to colour recall task scores (Section 6.3.37)

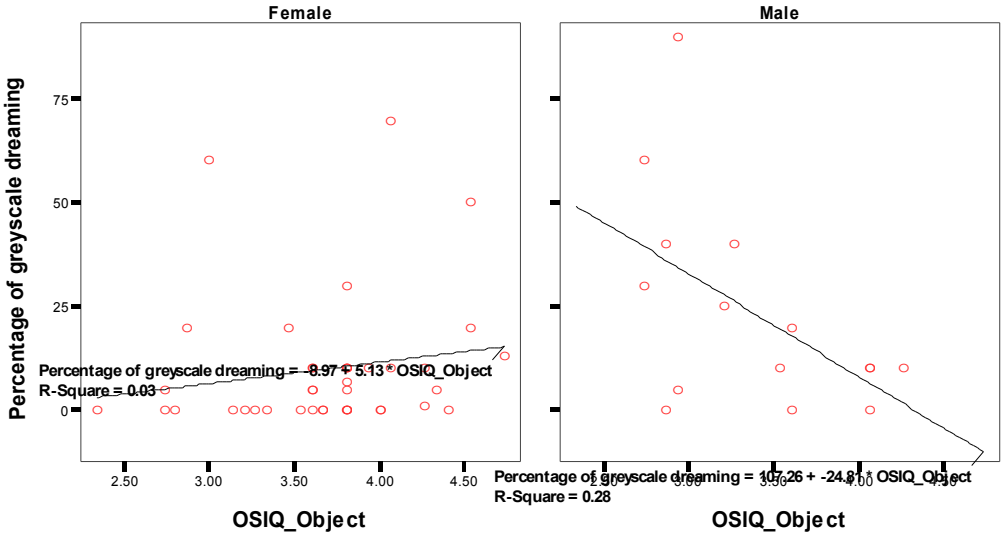


Appendix 19: Scatterplots for Experiment 7

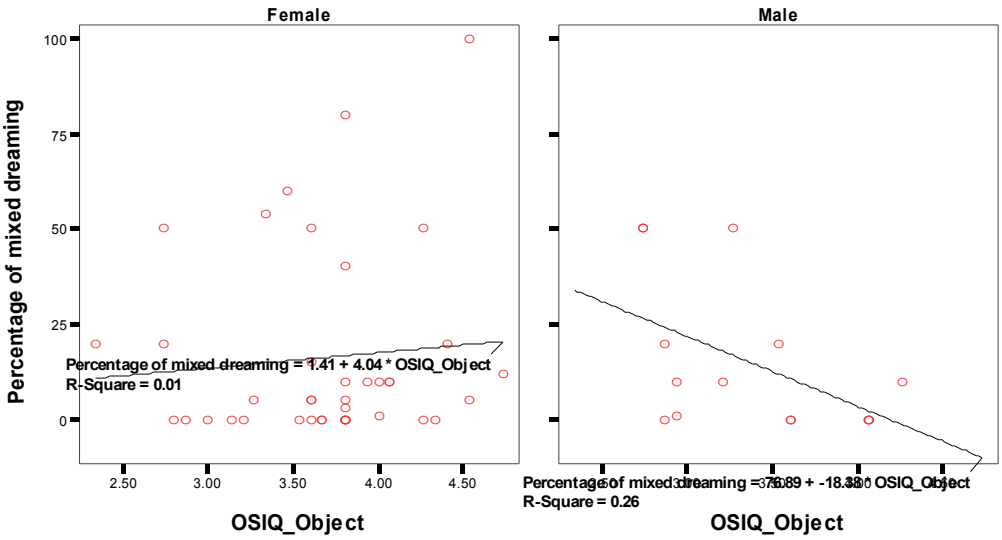
1. Sex differences in how Object Imagery scores correlate with frequency of coloured dreaming (Section 6.7.3.7)



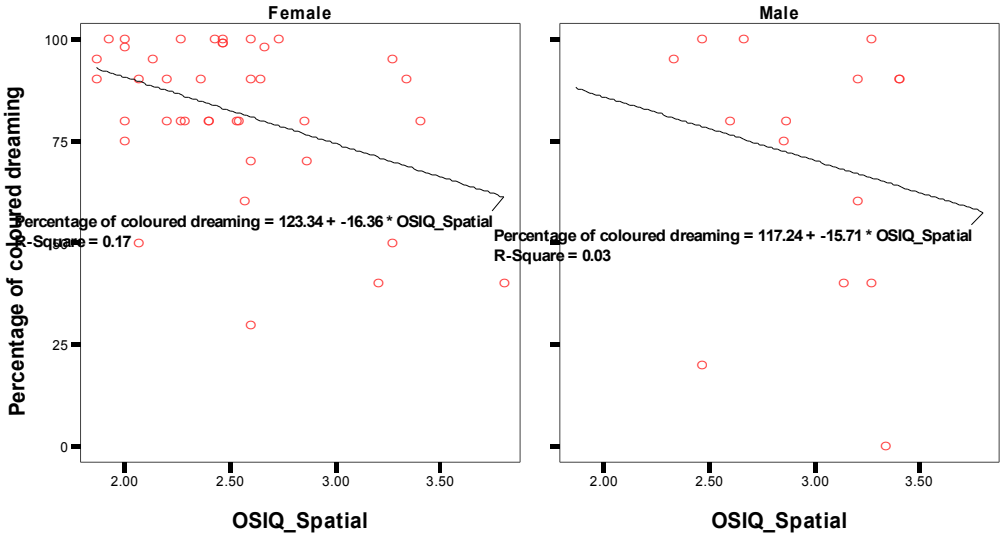
2. Sex differences in how Object Imagery scores correlate with frequency of greyscale dreaming (Section 6.7.3.7)



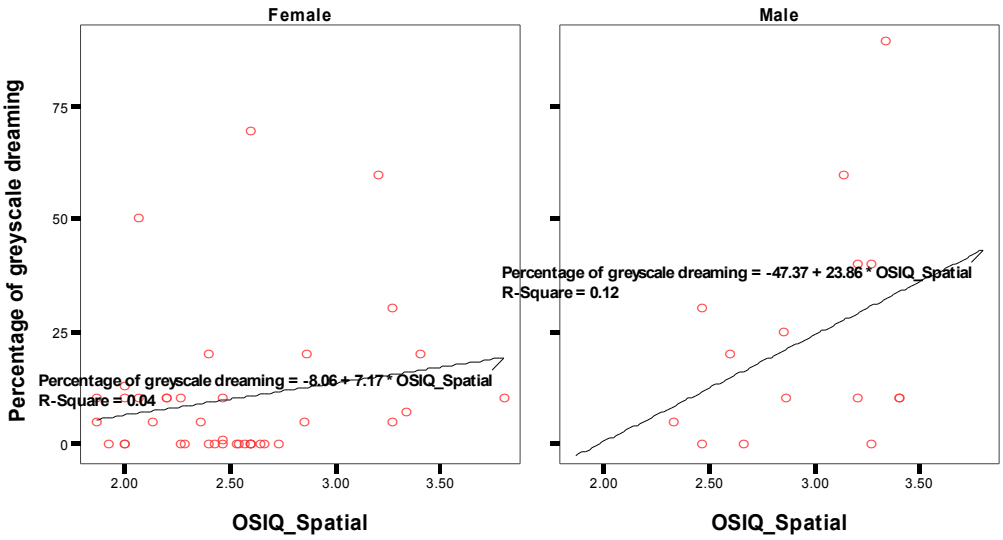
3. Sex differences in how Object Imagery scores correlate with frequency of mixed dreaming (Section 6.7.3.7)



4. Sex differences in how Spatial Imagery score correlate with frequency of coloured dreaming (Section 6.7.3.7)



5. Sex differences in how Spatial Imagery score correlate with frequency of greyscale dreaming (Section 6.7.3.7)



6. Sex differences in how Spatial Imagery score correlate with frequency of mixed dreaming (Section 6.7.3.7)